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U.S. Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

Oyster Creek Generating Station
Facility Operating License No. DPR-16
NRC Docket No. 50219

Subject: Response to NRC Request for Additional Information related to Severe Accident Management Alternatives (SAMA) for Oyster Creek Generating Station (TAC No. MC7625)

Reference: Letter, U.S. Nuclear Regulatory Commission (M. T. Masnik) to AmerGen Energy Company, LLC, (C. N. Swenson), dated November 9, 2005, "Request for Additional Information (RAI) Regarding Severe Accident Mitigation Alternatives (SAMA) for Oyster Creek Nuclear Generating Station (TAC No. MC7625)"

Enclosed, as requested in the referenced letter, are responses to the RAI associated with the topic of Severe Accident Management Alternatives (SAMA) as related to the AmerGen Energy Company, LLC, Oyster Creek Generating Station License Renewal Application.

Also enclosed are replacement pages providing updated information since submittal of the Oyster Creek Generating Station License Renewal Application Environmental Report. These updates reflect the effects of an updated Oyster Creek Fire Probabilistic Risk Assessment model, address inconsistencies, minor editorial changes and clarifications.

If you have any questions, please contact Bill Maher at 610-765-5939 or Fred Polaski, Manager License Renewal, at 610-765-5935.

I declare under penalty of perjury that the foregoing is true and correct.

Respectfully,

Executed on January 9, 2006

Pamela B. Cowan
Director - Licensing & Regulatory Affairs
AmerGen Energy Company, LLC

Enclosures: 1) Response to Request for Additional Information
2) Replacement Pages

cc: Regional Administrator, USNRC Region I, w/o Enclosures
USNRC Project Manager, NRR - License Renewal, Environmental, w/Enclosures
USNRC Project Manager, NRR - License Renewal, Safety, w/o Enclosures
USNRC Project Manager, NRR - Project Manager, OCGS, w/o Enclosures
USNRC Senior Resident Inspector, OCGS, w/o Enclosures
NJ DEP, BNE, w/Enclosures
Karen Tuccillo, NJ BNE, w/Enclosures
File No. 05040

A114

<u>Enclosure 1</u>

Response to Request for Additional Information Regarding Severe Accident Mitigation Alternatives

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

1a) Provide the core damage frequency (CDF) due to anticipated transients without scram events.

AmerGen Response:

Failure to scram accident sequences leading to core damage have been characterized in two accident classes:

- Class IC (loss of inventory with containment intact)
- Class IV (containment failure induces a loss of makeup capability)

It is noted that LOCAs with a failure to scram are included in Class IV also.

Table F-1 of Appendix F of the Environmental Report (ER) lists the contributors to CDF for Oyster Creek (OC). This table indicates that the Loss of Injection ATWS scenarios (Class IC) are included with other loss of high pressure injection scenarios (Class IA). Table F-1 lists a loss of high pressure injection CDF of 1.51E-6/yr for early sequences and 1.06E-6/yr for late sequences. Based on a review of the model quantification results, 1.08E-7/yr of the early sequences (1.51E-6/yr) is contributed from ATWS events (i.e., Class IC). This value can be added to the Class IV total noted in Table F-1 (1.81E-7/yr) to determine the total ATWS sequence contribution.

Therefore, the total failure to scram accident frequency leading to core damage is the combination of Class IC and IV.

Class	Frequency (per yr)
Class IC	1.08E-7
Class IV	1.81E-7
Total	2.89E-7

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

1b) Section F.2.1 includes a list of the major differences in the PRA model between the original individual plant examination (IPE) and the current PRA. None of these items appear to involve hardware modifications:

i. Confirm that no hardware modifications were major contributors to the change in CDF from the IPE to the current value.

ii. Identify those model changes that had the greatest impact on the CDF.

AmerGen Response:

1b) i The Oyster Creek PRA update process involved a review of all plant modifications. While most modifications do not impact the PRA, a number of modifications have led to explicit changes to the model. None of the hardware changes made since the Individual Plant Examination (IPE) have had a significant impact on the PRA model. The following table summarizes these changes.

Modification	Modification Description	PRA Impact
Core Spray Min Flow	The minimum flow bypass lines were modified during the 15R Outage (9/10/94 - 12/17/94) to eliminate potential for draining the core spray piping to the torus by a failure of the air-operated valves. The modification performed under BA# 403011 relocated the recirculation lines and replaced the original orifices with throttling valves located in the common recirculation lines. As part of the modification to the minimum flow line performed during Outage 15R, the air-operated valves were removed and replaced with manually operated gate and globe valves in each recirculation line. As part of the modification to the minimum flow bypass line, a manual Y-pattern globe valve was added to the System 2 test line to relieve vacuum conditions created when the test line is isolated following operation of the main and booster pumps. Similarly, during the 16R Outage a manual vacuum breaker assembly, consisting of a 1/2" globe valve and a 1/2" spring loaded check valve, was installed on the System 1 test line.	Minor change in core spray system failure modes.

Modification	Modification Description	PRA Impact
Main Steam Safety Valve Reduction Program	Safety valves have been retired. The PRA model includes the current total of 9 safety valves.	Minor change in the common-cause failure terms for RPV overpressure protection. Does not impact RPV depressurization.
Reactor RPV Overfill Protection	Oyster Creek has implemented a level setpoint setdown logic circuit for feedwater control. Also, a high level feedwater trip was implemented.	Minor change to RPV overfill scenario contributors.
Main Feedwater Block Valve Addition	Addition of block valves in feedwater supply lines to RPV	Minor change in feedwater system failure modes. Also, Minor change to RPV overfill scenario contributors.

None of these hardware changes had any significant impact on the PRA.

1b) ii As for the non-hardware changes noted in Section F.2.1, there has been no set of quantifications performed to determine the impact of individual model modifications. However, a qualitative review of results indicates that the following are the model changes that caused the most significant PRA quantitative changes:

- Addition of AC and DC initiating events (increased CDF)
- Addition of more detailed modeling of extreme weather and its impact on offsite AC power, the Combustion Turbine Building, and the Diesel Fire Pump Building (increased CDF)
- Addition of recirculation pump seal leakage scenario (increased CDF)
- Addition of induced LOOP events due to a transient or LOCA challenge (i.e., scram) (increased CDF)

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

1c) A 2004 self-assessment of the OCNGS PRA is described in Section F.2.5. Relative to this self-assessment, please indicate:

i. Which revision of the PRA was reviewed in the self-assessment.

ii. Who performed the review and their degree of independence relative to those who performed the PRA.

iii. If the version reviewed was not the 2004A update, those steps taken to ensure the adequacy of the 2004B revision, given the extensive changes between the 2001 and the 2004B revisions.

AmerGen Response:

1c) i The 2001 PRA model underwent the self-assessment process to identify the "gaps" between the PRA model (and documentation) and the ASME PRA Standard Supporting Requirements. This self-assessment resulted in identifying:

<u>123</u> "gaps" of the total 265 Supporting Requirements, i.e., they did not meet Capability Category II

The 2004A PRA update used this gap analysis as input to identify areas that could be upgraded to improve the scope and level of detail of the model. The results of the 2004A PRA model were then re-reviewed to establish the number of gaps that remained following the update.

<u>78</u> gaps were resolved in the 2004 update to meet the Capability Category II level.

<u>8</u> gaps were deferred awaiting NRC or EPRI guidance or Addendum A clarification.

<u>8</u> gaps were partially resolved.

<u>14</u> gaps were deferred due to very low impact on PRA.

<u>6</u> gaps were deferred that are medium impact on PRA.

<u>9</u> Internal Flood related gaps were deferred as Internal Flood was not updated (Awaiting EPRI Guidance on Internal Flooding).

<u>0</u> High impact gaps that did not meet Capability Category II remained.

1c) ii The self-assessment was performed by the PRA team leader, Dr. E.T. Burns. He is responsible for the PRA update and knowledgeable of each of the PRA elements, the methods used, the documentation, and how the ASME PRA Supporting Requirements were resolved.

This is consistent with the NEI self-assessment process attribute:

The process should be performed by knowledgeable PRA engineers with experience in the plant-specific PRA.

The self-assessment was reviewed by a second team member to ensure the accuracy of the evaluation, and the results were approved by an independent member of management.

1c) iii As stated in (i), the 2004A Oyster Creek PRA model was then reviewed as part of the finalization of the self-assessment process. A subsequent PRA update to incorporate additional plant insights (e.g., wind capability of on-site structures) was performed to provide the basis for the SAMA evaluation. This subsequent PRA update is the 2004B PRA model. The self-assessment performed for the 2004A model and documentation also applies to 2004B.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

1d) The modular accident analysis program (MAAP) and case identifiers in Table F-6A appear to include an accident class designator (e.g. IA, IB, and V). If this is correct, then the MAAP cases for a number of the consequence categories (e.g.1, 3, and 6) don't appear to be for the classes that are major contributors to the consequence categories as given in Table F-6. Describe the basis for the selection of the MAAP case used to determine the fission product release fractions and accident sequence timings for each consequence category.

AmerGen Response:

The MAAP Case identifiers are generally consistent with the accident class designators and also the MAAP cases used are selected to be representative of the bin.

The MACCS input uses the Oyster Creek specific MAAP cases to provide the deterministic release characteristics for each consequence category. The Level 1 and 2 end states or consequence categories require the selection of a representative MAAP case for each consequence category bin.

The following summarizes the selection of the MAAP cases for the three consequence categories noted in the RAI:

Category L2-1: This category is a transient with a loss of inventory makeup early in the sequence. The core melt progression fails the RPV and rapidly fails the drywell shell due to complete failure of all RPV and drywell injection cooling. The MAAP case selected is representative of both Class IA (early) and Class IBE Level 1 end states and as such represents the dominant sequences contributing to category L2-1 (H/E) 3.2E-7/yr of the 5.8E-7/yr total, i.e., more than 55% of the H/E category. (Refer to Table F-6 in Appendix F of the ER.)

Category L2-3: This category represents high magnitude and late releases following a large LOCA with a loss of effective containment heat removal. The MAAP case includes a primary system failure and a drywell failure for the release path. There may be some conservatism in that the suppression pool is saturated and core melt progression occurs after containment is failed. This is consistent with the dominant contributor to H/L, i.e., Class IIIC. It represents a frequency of 1.22E-7/yr of a total of 2.10E-7/yr. In addition, the only other contributor, Class IIIB, has essentially the same release characteristics.

Category L2-6: This category represents the medium magnitude releases that occur late (M/L). The sequence is a core melt progression that includes successful drywell sprays but a failure to successfully remove heat from containment. This leads to a late release from containment. The MAAP case used to represent this category is for a transient event. No available LOCA cases were available to characterize this low frequency (1.67E-9/yr) consequence category. Therefore, a sequence that met the timing and release magnitude characteristics was used to characterize the consequence category.

Subsequently, a MAAP case corresponding more closely to the contributors of the M/L category has been performed; it indicates that the selected MAAP case used to support Appendix F is slightly conservative. This may therefore slightly overestimate the benefit to be achieved when the M/L release category frequency is reduced by a SAMA.

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NRC RAI SAMA

1e) The Level 2 PRA appears to be essentially a complete revision of the IPE Level 2 analysis. Please confirm this and describe the reviews completed for the current Level 2 model and how the review findings have been addressed.

AmerGen Response:

The Oyster Creek IPE was developed by GPU and PLG using RISKMAN with very limited release categories. The SAMA evaluation is best described if multiple release categories are available.

Therefore, a complete Level 2 PRA was performed to assess the release categories and frequencies and to convert the model to CAFTA. As noted in response to RAI 1c, the Level 2 PRA has been reviewed relative to the ASME PRA Standard with the objective of meeting Capability Category II. To the extent that the ASME PRA Standard addresses the Level 2 structure, interfaces, and level of detail, those Supporting Requirements are all addressed in the Oyster Creek Level 2 PRA.

PRA models and documents that are developed by the Exelon Risk Management Team receive a review by another member of the Risk Management Team and the documents are approved by a third management person. Comments from this process are resolved and incorporated into the model and the associated documentation.

In addition, it is noted that the Level 2 was performed by the same PRA team that has performed the following Level 2 analyses:

Plant	Containment Type	Software Platform
• Vermont Yankee (1993)	Mark I	RISKMAN
• Limerick (1993)	Mark II	NUPRA
• Peach Bottom (1994)	Mark I	NUPRA
• Fermi (1994)	Mark I	RISKMAN
• Nine Mile Point 1 (1995)	Mark I	RISKMAN
• Nine Mile Point 2 (1995)	Mark II	RISKMAN
• Dresden (2002)	Mark I(1)	CAFTA
• Quad Cities (2002)	Mark I(1)	CAFTA
• LaSalle (2002)	Mark II	CAFTA

(1) Level 2 updated specifically to support the SAMA evaluation.

	Plant	Containment Type	Software Platform
•	Hope Creek (2003)	Mark I	CAFTA
•	Brunswick (2004)	Mark I[(1)]	CAFTA
•	Hatch (2005)	Mark I	CAFTA

(1) Level 2 updated specifically to support the SAMA evaluation.

The ANS Level 2 PRA Standard is currently under development and Dr. E.T. Burns, who was the team leader for the Oyster Creek Level 2 development, is also a member of the writing group developing the ANS Level 2 PRA Standard.

No peer review of the updated full Level 2 was performed, however, AmerGen has high confidence that the updated Level 2 is a realistic evaluation of the Oyster Creek plant and potential release frequencies, magnitudes, and timing based on the experience of the evaluation team and the comparison against the ASME PRA Standard.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

2a) The seismic individual plant examination of external events (IPEEE) assumed that all relays that didn't meet Unresolved Safety Issue A-46 requirements were replaced or otherwise shown to be adequate. The staff safety evaluation report (SER) for A-46 noted that, at the time of issuance, this had not been completed. Confirm that all relays that did not meet A-46 requirements have been replaced or otherwise shown to be adequate.

AmerGen Response:

All relays, which were determined to be in the scope of the A-46 requirements, were replaced or otherwise shown to be adequate.

The evaluation examined relays/contacts whose malfunction would result in a loss of Safe Shutdown function of the system/component and ensures the relay's seismic adequacy.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

2b) As described in Section F.1.2, the CDF for external events is 2.3 times the current internal events CDF; thus the total CDF is 3.3 times the internal events CDF. In the environmental report (ER), a factor of two multiplier is applied to the internal event benefits to reflect the potential for additional risk reduction in external events. The justification provided for use of the factor of 2 multiplier (rather than a factor closer to 3.3) is that the external events CDF is conservative and that a SAMA based on internal events insights would have a smaller benefit on external event risk than on internal event risk. These arguments need to be further substantiated, particularly in light of the fire analysis provided for SAMA 125.

AmerGen Response:

SAMAs identified to address primarily external events are evaluated using the latest available information with respect to that external event (e.g., seismic structural integrity, fire prevention). As a result, the external event SAMAs are judged to be appropriately evaluated, but in a conservative manner.

SAMAs identified to address primarily internal events are recognized to have some marginal benefit in external event mitigation. It is also recognized that:

(1) The dominant seismic risk contributors result primarily from the structural failure of multiple systems, structures, and components. The internal events SAMAs have little to no influence on these dominant seismic contributors.

(2) The fire risk is judged to be both conservatively quantified and to be only partially influenced by "internal event" SAMAs.[1] The fire risk estimate for Oyster Creek has been updated from that available at the time the Appendix F of the Environmental Report (ER) was originally prepared. The current Fire PRA result reflects a calculated CDF slightly less than the internal events CDF result. As such, the applied multiplication factor of two (2) to represent the fire external events impact is appropriate. Additional discussion and details related to the updated Fire PRA results are provided in the response to RAI Item 2c.

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(1) In the case of SAMA 109, an explicit fire model evaluation was performed as it was recognized that for SAMA 109 the fire risk profile would also be affected. This explicit evaluation is referred to as SAMA 125A.

The currently revised CDF estimates are as follows:

Contributor	Frequency (per year)
Internal Events	1.05E-05
Fire Events(1)	9.42E-06
Seismic Events	4.7E-06
Total	2.46E-05

Using this latest assessment of fire risk contribution, the total CDF is a factor of 2.3 increase above the internal events frequency. This is lower than the 3.3 reported in the Appendix F of the Environmental Report (ER). In addition, given the fact that seismic risk is only marginally influenced by SAMAs identified to mitigate internal events, it is reasonable to consider the effectiveness of internal event identified SAMAs to be adequately evaluated if the fire risk contribution can be treated using the surrogate model.

Therefore, if the seismic contributors are treated separately, e.g., resolving open IPEEE vulnerabilities, then the remaining contributors to the risk profile are as follows:

Contributor	Frequency (per year)
Internal Events	1.05E-05
Fire Events(1)	9.42E-06
Total	1.99E-05

By examining these contributors, this evaluation results in a multiplier of 1.9 times the internal events to represent a surrogate model that could reflect the fire risk contributors if the SAMAs were equally effective for internal events and fire events.

As a result, it is judged to be appropriate to calculate the SAMA effectiveness using the multiplier of 2.0 on the cost risk averted from the internal events PRA to realistically represent the input to decision makers to be obtained from the SAMAs.

(1) An update of the Fire PRA in 2005 to provide a more realistic assessment of risk reduced the estimated CDF from 1.9E-5/yr found in the IPEEE to 9.4E-6/yr in the 2005 fire PRA.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

2c) The evaluation of SAMA 125 includes a re-analysis of the fire risk for two of the dominant fire zones identified in the IPEEE. This revision utilized more current fire initiating event frequencies and the plant logic models and data for the latest revision of the internal events PRA and discovered a previously unquantified failure mode. The result is a fire CDF that is twice that for internal events. In this regard, provide the following:

i. Since only the two dominant fire zones were re-analyzed and they make up approximately 72 percent of the total fire CDF in the IPEEE, describe the impact on fire CDF if the remaining fire zones were re-analyzed.

ii. Discuss the impact of the increased fire CDF on the external event multiplier and on the results of the SAMA assessment.

AmerGen Response:

The results reported in Appendix F of the ER relied on the results of the original Fire IPEEE together with preliminary results from an ongoing Fire PRA update project. Those preliminary results in the Appendix F of the ER included the update of the fire analysis for those fire areas found to be dominant contributors in the Fire IPEEE.

As noted in the response to SAMA RAI Item 2b, the Fire PRA Reassessment for Oyster Creek has been completed. The updated analysis includes a comprehensive re-analysis of the entire plant. The results of the updated fire analysis show a cumulative calculated CDF of approximately 9.4E-6/yr.

With reference to the screening of fire areas, it is noted that the cost risk averted associated with the elimination of individual fire contributors to CDF in the range of 2.6E-7/yr is estimated at less than $50,000. This cost risk averted is considered quite low and would be insufficient to support any reasonable SAMA, including procedure changes. This information can be used effectively in determining which risk contributors may be prudent to have SAMA evaluations.

Table 2-1 provides the following changes in perspective for the fire induced risk as a result of the Fire Risk Reassessment from that evaluated in the IPEEE:

- The "A" 480VAC Switchgear Room fire induced risk is similar to that identified in the IPEEE RAI response and remains high at ~3.07E-06/yr. SAMA 125B reduces this risk contribution.
- The large risk identified in the IPEEE associated with a fire in the Cable Spreading Room has been reduced. This reduction in risk resulted from more detailed treatment of the fixed fire ignition sources in the room and incorporation of alternate mitigation measures from the remote shutdown panel.
- The Control Room risk remained similar to the IPEEE assessment and low.

- The A&B Battery Room, Tunnel, and Electric Tray Room (OB-FZ-8C) has significantly increased in severe accident frequency for the Fire Risk Reassessment. These increased risk contributors are explicitly discussed below.
- Battery Room South of 4160VAC Switchgear has been reassessed and is significantly lower in its CDF contribution because of an updated fire ignition frequency value and the use of the latest plant model to describe plant mitigation capability.

A comparison of the Fire IPEEE results to that obtained from the current updated analysis is provided below in Table 2-1.

The original Fire IPEEE reported that the dominant risk contribution was due to postulated fires originating in Fire Areas OB-FZ-6A and OB-FZ-4. The cumulative risk contribution from these two Fire Areas was 7.7E-06/yr. as originally reported in the Fire IPEEE Submittal report. The treatment of OB-FZ-4 was subsequently revised as summarized in the IPEEE SER(1). Using the updated estimates from the SER, the total for these two areas is 1.37E-05/yr. This is in contrast to the 3.5E-06/yr estimate obtained using the Fire PRA (FPRA) Reassessment. (See Table 2-1.)

The Fire PRA (FPRA) Reassessment shows that approximately 55% of the total calculated fire induced CDF is due to postulated fires originating in two Fire Areas. These Fire Areas are OB-FZ-6A and OB-FZ-8C.

Approximately 80% of the calculated CDF for OB-FZ-6A is due to postulated fire scenarios that result in damage to a cable that forms the connection between 480 VAC Unit Substations 1A2 and 1B2. The implementation of the proposed SAMA modification 125B (circuit breaker addition) would eliminate the associated failure mode and thereby eliminate these scenarios as contributors to risk.(2)

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(1) Pastis, H.N., (NRC) to DeGregorio (Amergen Energy), "Review of Oyster Creek Nuclear Generating Station Individual Plant Examination of External Events (IPEEE) Submittal (TAC No. M83652)," February 8, 2001.

(2) One of the insights discovered during the update to the Fire Risk Reassessment was an interaction in Fire Area OB-FA-6A that was not explicitly treated in the Fire IPEEE. This was described in the RAI as a fire induced failure having been 'previously unquantified'.

The fire induced failure that was characterized as having been previously unquantified involves the loss of a cable that forms the bus tie between 480 VAC Unit Substations 1A2 and 1B2. Although this failure mode was not quantified, its discovery did not ultimately translate to an increase in the calculated CDF for Fire Area OB-FA-6A relative to the IPEEE assessment. This is because of two key refinements in the analysis. One involves the use of only that fraction of the total area fire frequency that is associated with those fire ignition sources that are capable of causing the identified failure. The second involves crediting a recovery action described in the plant procedures that would restore power to the 480 VAC Unit Substation 1B2. In addition, a proposed plant modification was identified in the report as SAMA 125B. This modification would eliminate this failure mode and thereby further reduce the calculated fire related CDF contribution.

A review of the updated Fire PRA results for OB-FZ-8C determined that approximately 80% of the calculated CDF is due to fire scenarios involving self-initiated cable fires. The fire scenarios for OB-FZ-8C are summarized in Table 2-2. A review of the dominant risk contributors in the updated FPRA has been performed to gain insights as to whether additional SAMAs are required. These are reported below.

Fire Zone OB-FZ-8C Insight Review

An in-depth review of the "dominant" risk contributors for Fire Area OB-FZ-8C provides another indication of the conservatisms embedded within the current state of the fire PRA technology.

Scenario U – A postulated self-initiated cable fire is assumed to result in loss of all circuits in Tray 26. A review of the quantification results together with the set of fire induced circuit failures found that functional loss of ADS, DC distribution panel D, and trip circuits for the recirculation pump motors occur. The fire induced failure of DC Panel D results in failures that affect the availability of AC power on 480 VAC bus 1B3. The loss of power to 480VAC bus 1B3 affects the functionality of the Isolation Condenser due to loss of condensate makeup. The loss of power to 480 VAC bus 1B3 and the loss of trip circuits for the recirculation pump motors are recoverable using the existing plant procedures that are not explicitly credited in the FPRA quantifications. The combination of the recovery actions such as providing IC makeup from the Fire Protection System and the modification of the FPRA quantification to incorporate treatment of fire induced spurious actuation using a conditional probability reduces the unmitigated CDF estimate to less than 3.0E-07/yr. These unmitigated contributors to risk involve hardware failures that would require notable plant modifications to provide alternative (redundant) means of satisfying the associated function, or the rerouting of cables. The scope of cables that are involved include the power supply circuit to DC panel D and all ADS related circuits. Either alternative would involve an anticipated cost that is greater than the value of the incremental benefit (averted cost-risk) that can be gained, i.e., a cost greater than $50,000.

Scenario L – A postulated self-initiated cable fire is assumed to result in loss of all circuits in Tray 17. A review of the quantification results together with the set of fire induced circuit failures indicate a functional loss of DC system battery chargers occur. This fire induced failure would be mitigated by SAMA 109.

The incorporation of the updated FPRA results would therefore slightly increase the positive net value for SAMA 109.

Scenario T – A postulated self-initiated cable fire is assumed to result in the loss of all circuits in Tray 25. For the development of Table 2-2, this translated into the assumption that all ADS valves failed to operate. However, a review of the quantification results together with the set of fire induced circuit failures indicates that only a loss of ADS valve position indication occurs with no adverse effect on valve functionality. A requantification of the scenario results presented in Table 2-2 without the postulated failure of the ADS valves resulted in a substantial reduction in the calculated CDF – to less than 1E-09/yr. Based on this revised result, this scenario was screened with respect to SAMA treatment.

Residual Scenarios - The remaining fire scenarios for compartment FZ-OB-8C have calculated CDF values less than 2E-07/yr and also involve self-initiated cable fire events. Fire scenarios in this location involving fixed fire ignition sources such as electrical cabinets have calculated CDF values less than 2E-09/yr. The mitigation of the fire induced circuit failures require hardware changes or cable rerouting in order to achieve measurable reductions in calculated CDF. Based on the low risk contribution associated with these remaining scenarios any meaningful SAMA is expected to result in a negative net value. Therefore, no specific SAMA recommendations are developed for these remaining cases.

Fire Area OB-FZ-5 Insight Review

This fire compartment is the Main Control Room. The calculated CDF contribution from this compartment is based on the treatment of 15 individual fire scenarios. Nine of the scenarios collectively represent approximately 98% of this calculated CDF. Eight of these scenarios examine postulated main control room fires that are successfully suppressed and therefore do not force an abandonment of the main control room, but nevertheless, result in core damage. The quantification of these scenarios does not credit any recoveries that may be available through the use of the Remote Shutdown Panel. One scenario involves the postulated control room abandonment case. This abandonment case represents approximately 6% of the calculated CDF for the main control room.

The majority of the calculated CDF for the main control room is the result of fires that are successfully suppressed. These fires tend to cause damage to the panel interior that is relatively localized. Therefore, a realistic and measurable reduction in risk would require plant modifications at 8 different panels involving substantial relocation of internal panel wiring. Given the layout of the panels, it is anticipated that such a modification may also require installation of fire protective wraps and panel structural changes to create interior sub compartments. A cost estimate for such modifications was not specifically developed. However, given the need to develop such a modification at 8 panels, the cost is expected to be substantial and the net value negative, i.e., not cost beneficial.

Fire Area OB-FZ-10A Insight Review

This fire compartment is adjacent to the Main Control Room. The calculated CDF contribution from this compartment is due primarily to the mix of circuits that are routed in Tray 14. A postulated self-initiated cable fire in this tray is assumed to disable all associated circuits. This is because the specific arrangement of individual circuits within the tray cannot be determined. The treatment of this scenario did not apply a fire severity factor or credit the installed fire suppression system. The resultant fire risk estimate is characteristic of the inherent plant capability given loss of PCS and one isolation condenser. Further risk reduction would require substantial rerouting of circuits associated with ECCS. However, such rerouting of circuits would also 'relocate' the associated risk to a different cable tray.

The conservatism that exists in the risk estimate is primarily due to the lack of detailed cable functional and location information for PCS. As a consequence, the risk quantifications are biased with an assumed loss of PCS. Given the location of this tray and the nature of circuits (ECCS related) that are present, there is a degree of confidence that PCS related circuits are not present. However, this degree of confidence was not considered sufficient to warrant crediting PCS in the risk assessment. A risk reduction of greater than an order of magnitude occurs if PCS is credited. Given the anticipated substantial costs associated with rerouting circuits and the conservative nature of the calculated fire CDF value, a specific SAMA to address this compartment is not needed.

Fire Areas TB-FA-3A and TB-FA-3B Insight Review

These fire compartments are the two rooms containing the Safety Related Switchgear 1C and 1D. The risk estimate for these areas is dominated by the postulated loss of the switchgear bus itself and is a characteristic of the inherent plant capability given a two train electrical system.

The dominant sequence involves loss of DC due to battery depletion. This is effectively mitigated by SAMA 109.

Fire Area TB-FZ-11E Insight Review

This fire area is the Main Condenser area. The risk estimate developed for this area reflected an initial incorporation of the Main Generator hydrogen and oil fire scenarios discussed in NUREG/CR-6850. Consequently, there is minimal further development of this treatment pending additional industry experience and feedback on this methodology. Given the prescriptive treatment described in NUREG/CR-6850, the only effective risk mitigation measure would require the removal of all critical circuits by rerouting. Given the physical arrangement of the plant, it is anticipated that substantial application of fire rated wrap material or installation of new underground duct banks would be required. Although a cost estimate for such a modification was not developed, it is expected to involve significant costs. Given the limited refinement associated with these scenarios and the anticipated high cost of plant modifications, this compartment was assessed to have no viable cost beneficial SAMA.

Fire Area MT-FA-12 Insight Review

This is the Main Transformer area adjacent to the plant Turbine Building. The dominant fire scenario involves a postulated fire in the Main Transformer. The fire is conservatively assumed to disable the bus duct from the Startup Transformers SA and SB. The treatment conservatively does not credit the fire suppression system or apply a fire severity factor. If these factors were credited in the Fire PRA, the CDF associated with this area would be reduced by at least an order of magnitude. A potential SAMA consists of rerouting or otherwise protecting the bus duct from transformer SB so that it would remain unaffected given a postulated fire event. The cost of such a modification could be significant because there is no clear physical means to provide such protection[(1)]. In addition, if the fire risk assessment were further refined to credit fire severity and the existing fire suppression system, the magnitude of any risk reduction could be very minimal. Given the limited refinement associated with this fire scenario and the lack of any clear means to provide meaningful physical protection from fire, this compartment was assessed to have no viable cost beneficial SAMA.

(1) See SAMA 138. SAMA 138 evaluated the cost benefit associated with mitigating an explosive failure of one transformer affecting both the main and start up transformers. The assumed frequency of the event in SAMA 138 is higher than that for the fire in area MT-FA-12, but the modification cost to mitigate against it is judged to be similar to that for SAMA 138.

TABLE 2-1: Comparison of Fire IPEEE Results to Updated FPRA

Fire Area	Fire Area Description	Fire IPEEE		Updated FPRA		
		CDF (per yr)	Source	CDF (per yr)	% of Fire Induced CDF	FPRA Risk Rank
OFFICE BUILDING FIRE AREAS AND ZONES						
OB-FZ-4	Cable Spreading Room - 36' Elevation	8.60E-06	IPEEE RAI Response	3.86E-07	4.1%	7
OB-FZ-5	Control Room - 46' 6" Elevation	3.3E-07	Fire IPEEE	4.28E-07	4.5%	5
OB-FZ-6A	"A" 480 VAC Switchgear Room	5.1E-06	Fire IPEEE	3.07E-06	32.6%	1
OB-FZ-6B	"B" 480 VAC Switchgear Room	Screened	Fire IPEEE	1.87E-07	2.0%	11
OB-FZ-8A/B	MG Set Room / Mechanical Equipment Room	Screened	Fire IPEEE	4.30E-08	0.5%	19
OB-FZ-8C	A and B Batt Room, Tunnel and Elec Tray Room (35' El)	4.58E-07	IPEEE RAI Response	2.11E-06	22.4%	2
OB-FA-9	Office Building	Screened	Fire IPEEE	1.19E-08	0.1%	26
OB-FZ-10A	Monitoring and Change Room - 46'	Screened	Fire IPEEE	3.78E-07	4.0%	8
OB-FZ-10B	Chem Lab, Laundry, Instrument Shop - 35'	Screened	Fire IPEEE	Screened	--	--
OB-FA-22A	New Cable Spreading Room (Mech Equip Room) 63' 6" El.	Screened	Fire IPEEE	5.73E-08	0.6%	18
OB-FA-22B	North Cable Bridge Tunnel, 74' 6"	Screened	Fire IPEEE	3.71E-09	<0.1%	--

TABLE 2-1: Comparison of Fire IPEEE Results to Updated FPRA

Fire Area	Fire Area Description	Fire IPEEE		Updated FPRA		
		CDF (per yr)	Source	CDF (per yr)	% of Fire Induced CDF	FPRA Risk Rank
OB-FZ-22C	South Cable Bridge Tunnel	Screened	Fire IPEEE	1.01E-09	<0.1%	--
TURBINE BUILDING FIRE AREAS AND ZONES						
TB-FA-3A	4160 VAC Switchgear 1C Vault (TB Mezz - 23')	Screened	Fire IPEEE	5.05E-07	5.4%	4
TB-FA-3B	4160 VAC Switchgear 1D Vault (TB Mezz - 23')	Screened	Fire IPEEE	3.26E-07	3.5%	9
TB-FZ-11A	Turbine Operating Floor - 46' Elevation	Screened	Fire IPEEE	8.87E-09	<0.1%	--
TB-FZ-11B	Lube Oil Storage, Pumping and Purification Areas, 0' & 27'	Screened	Fire IPEEE	9.18E-08	1.0%	15
TB-FZ-11C	Swgr Room, West End of TB on Mezz Level (Elev. 23' 6")	Screened	Fire IPEEE	9.42E-08	1.0%	13
TB-FZ-11D	Basement Floor, South End	1.91E-06	IPEEE RAI Response	6.20E-08	0.7%	17
TB-FZ-11E	Condenser Bay, Elevation 3' 6"	Screened	Fire IPEEE	5.99E-07	6.4%	3
TB-FZ-11F	Feedwater Pump Area, 0'6" & 3'6" Levels	Screened	Fire IPEEE	2.16E-08	0.2%	21
TB-FZ-11G	Mezzanine Level SE Corner and Machine Shop, El 23' 6"	Screened	Fire IPEEE	1.71E-08	0.2%	23
TB-FZ-11H	Demin Tank and Steam Jet Air Ejector Area, El 23' 6"	Screened	Fire IPEEE	2.02E-08	0.2%	22
TB-FA-26	Battery Room South of 4160 VAC Switchgear	7.6E-07	Fire IPEEE	7.50E-09	<0.1%	--

TABLE 2-1: Comparison of Fire IPEEE Results to Updated FPRA

Fire Area	Fire Area Description	Fire IPEEE		Updated FPRA		
		CDF (per yr)	Source	CDF (per yr)	% of Fire Induced CDF	FPRA Risk Rank
REACTOR BUILDING FIRE ZONES						
RB-FZ-1B	95 Foot Elevation	Screened	Fire IPEEE	Screened	--	--
RB-FZ-1C	75 Foot Elevation	Screened	Fire IPEEE	1.19E-08	0.1%	27
RB-FZ-1D	51 Foot Elevation	2.43E-07	IPEEE RAI Response	9.00E-09	<0.1%	--
RB-FZ-1E	Main Floor (23 Foot Elevation)	1.16E-07	IPEEE RAI Response	2.12E-07	2.3%	10
RB-FZ-1F	Torus Area & Corner Rooms (-19')	Screened	Fire IPEEE	1.52E-08	0.2%	24
RB-FZ-1G	Shutdown Cooling Area (38' and 51')	Screened	Fire IPEEE	1.36E-07	1.4%	12
RB-FZ-1H	Trunnion Room (23' 6" Elevation)	Screened	Fire IPEEE	Screened	--	--
OTHER PLANT FIRE AREAS						
MT-FA-12	Main Transformer and CST	Screened	Fire IPEEE	3.92E-07	4.2%	6
DG-FA-15	No. 1 Diesel Generator Room	Screened	Fire IPEEE	9.30E-08	1.0%	14
DG-FA-17	No. 2 Diesel Generator Room	Screened	Fire IPEEE	7.86E-08	0.8%	16
FS-FA-16	Emergency Diesel Fuel Storage Area	Screened	Fire IPEEE	Screened	--	--
CW-FA-14	Circulating Water Intake Area	Screened	Fire IPEEE	1.26E-08	0.1%	25
YARD	Outside Areas	Screened	Fire IPEEE	3.55E-08	0.4%	20
TOTAL CALCULATED FIGURE OF MERIT		1.75E-05		9.42E-06	100%	

TABLE 2-2: *Summary of Results for OB-FZ-8C from Updated FPRA* Without Credit for Recovery or the Probabilistic Treatment of Spurious Actuation

Scen	Scenario Description	Frequency (per yr)	CCDP	CDF (per yr)	% of Total Fire CDF	Cumulative % of Total CDF	Cumulative % of Fire Area CDF
U(1)	Non-Severe Tray 26 Fire - No LOIA	3.19E-05	2.09E-02	6.68E-07(2)	7.1%	7.1%	31.6%
L(1)	Non-Severe Tray 17 Fire - USS Recvr Fails, No LOIA	1.28E-06	3.33E-01	4.26E-07	4.5%	11.6%	51.8%
T(1)	Non-Severe Tray 25 Fire - No LOIA	3.19E-05	7.17E-03	2.29E-07(3)	2.4%	14.0%	62.6%
V	Severe Tray Stack 15 - 18 Fire	4.09E-07	4.08E-01	1.67E-07	1.8%	15.8%	70.5%
I	Cable Fire - Severe - All - No Man/Auto Supp	2.50E-07	5.57E-01	1.39E-07	1.5%	17.3%	77.1%
P	Non-Severe Tray 21 Fire - No LOIA	1.28E-05	1.06E-02	1.36E-07	1.4%	18.7%	83.6%
Y	Non-Severe Tray 17 Fire - USS Recvr Succ, No LOIA	1.15E-05	9.69E-03	1.12E-07	1.2%	19.9%	88.8%
K	Non-Severe Tray 16 Fire - No LOIA	1.28E-05	7.17E-03	9.15E-08	1.0%	20.9%	93.2%
S	Non-Severe Tray 24 Fire - No LOIA	3.19E-05	2.68E-03	8.56E-08	0.9%	21.8%	97.2%
X	Severe Tray Stack 23 - 26 Fire	1.02E-06	3.23E-02	3.31E-08	0.4%	22.1%	98.8%
R	Non-Severe Tray 23 Fire - No LOIA	3.19E-05	4.14E-04	1.32E-08	0.1%	22.3%	99.4%
W	Severe Tray Stack 19 - 22 Fire	4.09E-07	1.45E-02	5.92E-09	0.1%	22.3%	99.7%
H	Static Battery Charger - Severe Fire	3.66E-04	4.45E-06	1.63E-09	0.0%	22.4%	99.8%
F	125 VDC Bus B	2.79E-04	4.45E-06	1.24E-09	0.0%	22.4%	99.8%
G	Static Battery Charger non-Severe Fire	1.46E-03	7.57E-07	1.11E-09	0.0%	22.4%	99.9%
O	Non-Severe Tray 20 Fire - No LOIA	1.28E-05	6.36E-05	8.11E-10	0.0%	22.4%	99.9%
N	Non-Severe Tray 19 Fire - No LOIA	1.28E-05	3.11E-05	3.97E-10	0.0%	22.4%	99.9%
M	Non-Severe Tray 18 Fire - No LOIA	1.28E-05	2.43E-05	3.10E-10	0.0%	22.4%	100.0%
J	Non-Severe Tray 15 Fire - No LOIA	1.28E-05	1.76E-05	2.25E-10	0.0%	22.4%	100.0%
Q	Non-Severe Tray 22 Fire - No LOIA	1.28E-05	1.76E-05	2.24E-10	0.0%	22.4%	100.0%
E	125 VDC Bus A	2.79E-04	7.58E-07	2.11E-10	0.0%	22.4%	100.0%

TABLE 2-2: Summary of Results for OB-FZ-8C from Updated FPRA Without Credit for Recovery or the Probabilistic Treatment of Spurious Actuation

Scen	Scenario Description	Frequency (per yr)	CCDP	CDF (per yr)	% of Total Fire CDF	Cumulative % of Total CDF	Cumulative % of Fire Area CDF
B	Battery Chgr MG Set A	1.44E-04	7.58E-07	1.09E-10	0.0%	22.4%	100.0%
C	Battery Chgr MG Set B	1.44E-04	7.57E-07	1.09E-10	0.0%	22.4%	100.0%
D	Rotary Inverter MG Set	1.44E-04	7.57E-07	1.09E-10	0.0%	22.4%	100.0%
	Total			2.11E-06[4]	22.4%		

Notes to Table 2-2:

(1) Scenarios examined in greater detail to assess any conservatisms and to investigate possible SAMAs.

(2) Upon more detailed review of existing mitigation measures, this CDF is assessed to be more realistically calculated as 2.5E-07/yr.

(3) Upon a more detailed review of the assumptions used in the FPRA, it is found that the fire induced CDF is more realistically calculated to be less than 1E-09/yr.

(4) CDF total based upon summation of all unscreened compartments retained in Table 2-2.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

3a) In Table F-13, event OHECD1 has a risk reduction worth of 1.056, which indicates that the CDF would be reduced by about 5 percent if this operator error were reduced significantly. This event is stated to be addressed by SAMAs 92 and 127. In the evaluation of SAMA 92, the CDF is decreased by only 2 percent. A SAMA that would automate the opening of the control rod drive manual bypass valve would be possible and might lead to a CDF reduction closer to the 5 percent. Explain the difference between the expected and calculated CDF reductions, and whether automatic actuation of the bypass valve could be cost-beneficial.

AmerGen Response:

Basic event OHECD1 (equal to 0.29) represents operators failing to maximize CRD flow and, as correctly pointed out by the NRC, its elimination as a failure mode would reduce CDF by approximately 5%. SAMA 92 eliminates a current procedural limitation on the crew that would then allow increased CRD flow. Therefore, SAMA 92 would not eliminate the need for operator action as it deals with allowing additional system flow to the RPV (i.e., up to 220 gpm versus 150 gpm maximum allowed by current procedures). Its specified 2% CDF reduction is reasonable considering manual operator actions are still necessary.

The alternate improvement suggested by the NRC, modification to make the CRD flow maximization automatic, would require plant modification but would directly address the need for operator action. By extrapolating the benefit of SAMA 92, $36,000, the approximate benefit of the modification can be estimated.

The expected benefit for complete elimination of the dependence on OHECD1 is $90,000 (i.e., $36,000*(5%/2%)). In order to accomplish this improvement, it is envisioned that the CRD bypass line would need to be refitted with an automatic flow control valve. However, this modification would divert flow from the CRD accumulators by bypassing the charging headers. This would adversely impact the CRD SCRAM function and may introduce a safety question regarding CRD system design (i.e., a potential competing risk). In order to address this impact, a fairly sophisticated control system would be required to assure that the valve does not open when CRD accumulators require charging flow. This improvement is judged to cost in excess of the $90,000 estimated benefit, i.e., greater than $250,000 total, composed of $100,000 for engineering analysis, plus an additional $100,000 for the control system and valve, plus $50,000 for implementation. The net value would then be -$160,000.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

3b) The disposition of Phase I SAMA 36 in Table F-15 makes reference to SAMA 90. However, SAMA 90 is listed as "not used." Similarly, the disposition of Phase I SAMA 82 makes reference to SAMA 126 which is listed as "not used." Provide the correct references for SAMAs 36 and 82.

AmerGen Response:

The disposition of SAMA 36 in Table F-15 should reference SAMA 89. In the same table, SAMA 82 should reference only SAMA 125.

To correct these editorial errors, Appendix F sheets have been provided as Enclosure 2 of this submittal.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

4a) SAMAs 10 and 84 both involve the containment venting system. SAMA 10 involves the installation of a passive over-pressure relief capability and is estimated to result in a CDF reduction of 15 percent. SAMA 84 involves a modification to enable manual operation of the containment vent valves without support systems and is estimated to result in a CDF reduction of 1.7 percent. SAMA 10 was evaluated by eliminating a number of operator actions from the model but apparently does not change the hardware failure contributions to venting. SAMA 84 was evaluated by adding a redundant operator action to vent containment. One would expect the CDF reduction for these two SAMAs to be similar. Explain the reasons for the differences in the estimated CDF reduction for these SAMAs. Describe in more detail how the existing containment vent system is modeled in the PRA, and the specific plant modifications associated with the two SAMAs.

AmerGen Response:

The existing containment vent model includes basic events for operator action, valves which must open on demand, relays which must function on demand, maintenance unavailability, and required support systems. Because the Oyster Creek containment vent valves have installed accumulator on AOVs, the failure of the instrument air support is not a significant contributor to the vent system failure probability. However, the current hard pipe vent operation for Oyster Creek requires operator action in the yard outside the Reactor Building.

SAMA 10 represents a plant modification to convert the containment venting function to a completely passive design for example, a single or multiple rupture disk arrangement. As described in Section F.6.2, this would eliminate support system and operator action failure modes. Because the operator actions represent a significant contributor to the vent unavailability, SAMA 10 has a relatively large benefit associated with its implementation. (On the other hand, SAMA 84 still requires the existing crew action in the yard and adds other crew manipulations as redundant methods for valve operation.) In order to quantify the benefit of SAMA 10, these operator failure modes were removed from the model. In order to approximate the contribution from rupture disks, or the equivalent, in the proposed design, hardware failure modes were left in the model. This modification resulted in a negative overall benefit, when compared to estimated costs. Also, as discussed in Section F.6.2 of Appendix F of the ER, the SAMA 10 modification would have significant competing risks that were only characterized qualitatively, but would further reduce any benefit associated with SAMA 10.

SAMA 84 involves installation of handwheels to allow local manual operation in cases where support systems fail. It should be noted that Oyster Creek has dedicated air accumulators for containment venting as well as an automatic power transfer capability (CIP-3 power supply) to allow 125 VDC Division B or two separate 480 VAC supplies to support the containment venting system. Because the support system failure contribution to containment venting failure is a small contributor at Oyster Creek, the benefit of the potential enhancement to merely address support system failure elimination is more modest.

Summary

Table 4a-1 summarizes the comparison of the two cited SAMAs. Table 4a-1 identifies the reduction in CDF achieved by the SAMA and the residual failure modes that remain after the SAMAs are implemented.

Table 4a-1

SUMMARY OF CONTAINMENT VENT SAMAs

SAMA	Description	CDF Reduction Associated with SAMA	Residual Risk Contributors
10	Passive over pressure containment vent	15%	• Hardware failures • Maintenance unavailability
84	Valve hand wheels in the Reactor Building to open AOVs in the current vent path	1.7%	• Crew action to vent containment • Hardware failures • Maintenance unavailability

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

4b) In the evaluation of SAMA 67 (Section F.6.7), a revised baseline CDF and risk are determined using the seismic CDF of 3.63E-06 per year from the original IPEEE submittal and applying the release category frequency distribution for Class 1A (early) from the internal events baseline model. Both of these assumptions are questionable. As indicated in the IPEEE SER, the seismic CDF of 3.63E-6 per year was subsequently increased to 4.7E-06 per year. As indicated in Section F.6.27.3, seismic CDF is dominated by Class 1B (early) events and Class 1A (early) events do not have a major contribution. Accordingly, the use of the higher CDF and the release category frequency distribution for Class 1B would appear more appropriate. The NRC staff also notes that the seismic baseline risk developed for SAMA 124 appears applicable for SAMA 67 as well. Address these items and provide a revised evaluation of SAMA 67, as appropriate.

AmerGen Response:

SAMA 67 deals with a proposal to increase the structural capability of the CST to improve its availability in seismic events. The existing Oyster Creek IPEEE model uses Gate "SX" to represent the seismic induced failures of the CST. As described in the IPEEE submittal, this gate has a 0.31 Fussell-Vesely (FV) importance corresponding to the 3.63E-6/yr seismic CDF described in the IPEEE.

During the IPEEE RAI process an alternative model was discussed which yielded a seismic CDF of 4.7E-6/yr. This alternative model is discussed in the June 29, 2000 RAI response to the NRC. On Page 30 of this RAI response, Oyster Creek reported that the SX top event has a 5.48E-2 FV when using the alternative seismic PRA model with a CDF of 4.7E-6/yr. The larger risk reduction is calculated using the IPEEE values for the related risk contribution. Thus, for sequences related to this issue, it is more conservative to assess the benefit using the IPEEE seismic model (i.e., 3.63E-6/yr*0.31 = 1.13E-6/yr versus 4.7E-6/yr*0.0548 = 2.58E-7/yr).

As noted by the NRC, the seismic CDF is dominated by SBO scenarios.

The selection of the Class IA release categories for the seismic induced CDF may underestimate the risk. Therefore, to provide a closer representation of the potential benefit, NRC's suggestion of using the approach of SAMA 124 is incorporated into SAMA 67. The gap between the averted cost-risk ($65,000) and the cost of SAMA 67 ($1,000,000) is sufficiently large that the resulting small differences in the analysis represent no impact on the input to the decision makers.

Nevertheless, the SAMA has been re-evaluated. The sheets are provided in Enclosure 2 of this submittal.

The SAMA remains not cost beneficial.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

4c) The evaluation of SAMA 91 (Section F.6.11) includes a description of modeling the benefit of the SAMA for non-loss of offsite power cases. This description indicates the addition of an "OR" gate that includes opposite division basic events. Clarify how this results in a reduction in CDF.

AmerGen Response:

Figure 4C-1 includes the gate structure added to the base model to incorporate the benefit of SAMA 91 under Gate EC (Safety Related Bus 1C). There is a similar arrangement in the model for gate "ED".

The "OR" gate referenced in the submittal (SAMA 91-EC) groups the opposite train hardware as well as an operator action to perform the proposed cross-tie action as failure modes which could fail the cross-tie function. It is noted that this new gate, SAMA91-EC, is added under the existing "ECG00MDB" gate in order to quantify the benefit of the modification.

It should be pointed out that the existing gate is an "AND" gate which includes separate logic inputs for supply from offsite sources as well as the divisional EDG. Thus, the new "OR" gate is "ANDed" into the existing model to account for the additional bus supply flexibility associated with the cross-tie.

Therefore, the failure of the cross-tie is represented by an "AND" of the cross tie with the divisional power supplies (Gate ECG00MDB). Under the "AND" gate, there is the subject "OR" gate.

In summary, the inclusion of the SAMA under the "AND" gate ECG00MDB results in requiring additional failures to fail the gate. This leads to a reduction in the failure probability of Gate EC and the CDF if the SAMA is implemented.

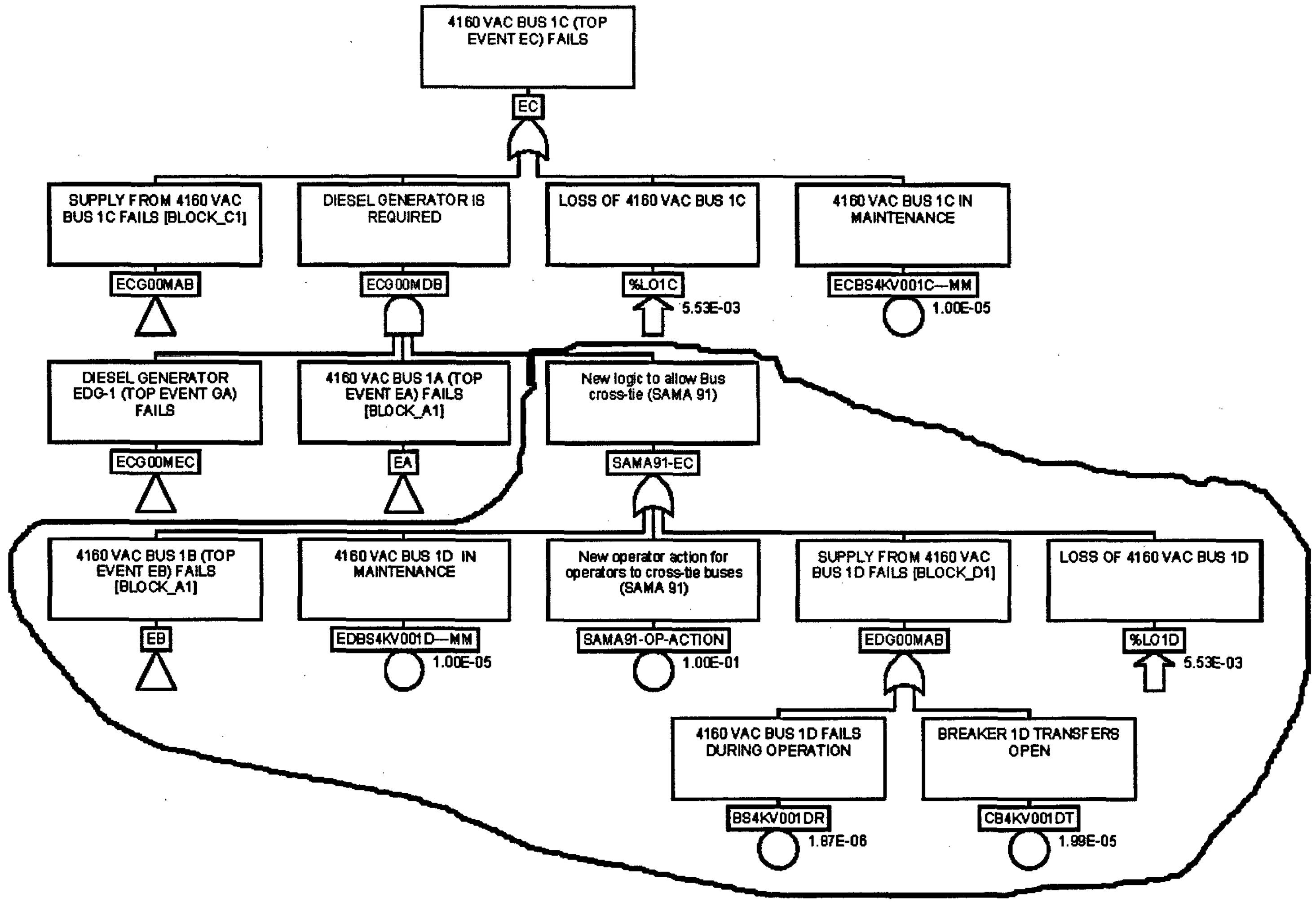

Figure 4c-1 Gate Structure Added to Represent SAMA 91

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

4d) The net value table for SAMA 100 (Section F.6.16) indicates a base case cost risk of \$4,462,000. This reflects a factor of 2 multiplier to account for external events, and is inconsistent with Note 2 to the table which states that a multiplier of 1.0 is used. The NRC staff estimates a net value of -\$420 thousand, using a multiplier of 1.0 versus the -\$354 thousand given in the ER. Clarify these apparent discrepancies.

AmerGen Response:

The factor of 2 applies because the SAMA would apply in internal as well as external scenarios. While it could be argued that this SAMA would be failed, due to the fragility of its key components in the bulk of the significant external event scenarios, it is judged appropriate and conservative to consider the benefit as potentially applicable in all scenarios. Thus, note 2 should not be referenced for this SAMA. The calculation presented in the submittal is correct.

A replacement sheet has been included as Enclosure 2 of this submittal.

There are no changes to the resulting cost benefit analyses and sensitivity case results from this editorial error.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

4e) SAMA 109 is evaluated in two different sections of the ER with two different results. The evaluation of SAMA 109 contained in Section F.6.23 appears to take credit for the direct current supply only for station blackout scenarios and results in a 15.6 percent reduction in CDF and a net value of $599 thousand. The evaluation of SAMA 109 contained in Section F.6.28 (where this SAMA is re-named SAMA 125A) results in over a factor of 2 reduction in the revised CDF (that includes the fire contribution from the two dominant fire zones) and a net value of $3.3 million. Explain any differences in the assumed SAMA, i.e., plant modifications, and the modeling of the SAMA between these two sections.

AmerGen Response:

Purpose

The purpose of Section F.6.28 is to assess the benefit of SAMA 125B. In order to develop a suitable surrogate baseline model to measure the benefit of SAMA 125B, the surrogate model was re-baselined by assuming that SAMA 109 is implemented.[1]

Differences in assumed SAMA: None

SAMA 109 is to provide a portable battery charger capable of supplying 125V DC buses. This would provide a significant benefit in station blackout and similar sequences where battery capacity determines the time window for operator response, e.g., the longer the time window for AC power recovery or IC operation, the higher the success probability.

SAMA 125A is an evaluation of the same SAMA as described in SAMA 109, however, the SAMA 125A has been implemented in a modified base PRA model that includes internal events and an approximation of key fire scenarios that could be influenced by the SAMA. This results in a surrogate PRA model to be used to assess SAMA 125B and its impact on the cost benefit assessment.

(The 125B SAMA is to add a circuit breaker to bus 1B2 to protect the bus from cross-tie cable shorts initiated by fires in the 480 VAC "A" switchgear room.)

In other words, both sections refer to the same plant improvement; the addition of a portable battery charger to maintain DC capability in long-term SBO type scenarios. This would also include cases where offsite power is available but cannot be utilized for key equipment due to distribution failures.

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(1) *The sole purpose of the re-baseline was to provide a reasonable base from which to measure the benefit of SAMA 125B. The calculated benefit for SAMA 125A is not considered to be relevant as the surrogate model before re-baselining is judged too conservative.*

Differences in Modeling:

Section F.6.23 of Appendix F of the ER (SAMA 109) addresses the benefit of the portable DC battery charger modification as quantified by the existing internal events PRA model (assuming that external events including fire represent a factor two (2) increase in the CDF risk profile) and demonstrates it to be cost-beneficial.

Because Oyster Creek did not have fire scenarios explicitly linked in its PRA model, SAMAs related to fire risk were evaluated separately. In this fire assessment, it is noted that the dominant fires involved SBO-like conditions. As such, the benefit of the portable charger SAMA is investigated for these scenarios. It is determined that the hypothetical benefit of the SAMA is higher when the averted fire risk using the preliminary fire reassessment results available in early 2005 are considered to be potentially mitigated by the SAMA. This occurs because the dominant fire scenarios are SBO-like in nature. Therefore, the Section F.6.28 model (Appendix F of the ER) for the SAMA 109 is performed on a surrogate model that included both internal events and certain fire initiated accident sequences that may be influenced by SAMA 125B. This resulting surrogate baseline model is referred to as SAMA 125A and assumes the implementation of SAMA 109. This surrogate baseline model (125A) is then used solely as the "base" to assess the reduction in risk if SAMA 125B is added on top of SAMA 109 (i.e., SAMA 125A).

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

4f) In establishing the baseline for evaluating SAMA 125B (Section F.6.28), SAMA 109 (also referred to as SAMA 125A) is assumed to have already been implemented. Similarly, both SAMA 109/125A and SAMA 125B are assumed to have been implemented in establishing the baseline for evaluating SAMA 125C. SAMA 125C is not cost beneficial when prior implementation of SAMA 109/125A and SAMA 125B are assumed, but might be if these SAMAs are not implemented. Since there is no commitment for implementing SAMA 109/125A or SAMA 125B, it is inappropriate to credit their implementation when assessing the benefits of SAMA 125B and SAMA 125C, respectively. Provide either: a commitment regarding implementation of SAMA 109/125A and SAMA 125B, or the results of separate cost benefit assessments of SAMA 125A, SAMA 125B, and SAMA 125C.

AmerGen Response:

This item is addressed by Note 1 on page F-274 of Appendix F of the Environmental Report (ER). This note indicates that SAMA 125B is cost-beneficial regardless of SAMA 109/125A implementation. It also indicated that SAMA 125C should be considered for implementation if SAMA 109 is not implemented. The following provides an excerpt of this note:

> It is noted that SAMA 125 relates to a reduction in the fire induced CDF in the 480V AC switchgear room and is found to be cost beneficial with or without SAMA 109 implementation. If SAMA 109 is not implemented, the more capital intensive change 125C should be considered.

As requested, the results of a separate cost benefit assessment treating SAMAs 125A, 125B, and 125C individually and independently is provided in Table 4F-1.

Table 4F-1

SUMMARY OF COST BENEFIT ANALYSIS RESULTS CONSIDERING SAMAs 125A, 125B, AND 125C INDIVIDUALLY AND INDEPENDENTLY OF ANY OTHER SAMAs

SAMA	Sensitivity Case Description	Net Value(1)	Basis for Net Value(1)
125A	Provide a portable DC battery charger.	$599,000	This is the same as SAMA 109. This is listed as cost-beneficial in Appendix F. The net value is $599,000. Section F.6.23 is used as the basis (including the factor of 2 times the impact on internal events to include external events)
125B	Add a circuit breaker for the bus 1B2 to protect if from a fire in 480VAC "A" switchgear room.	$907,000	No credit included for SAMA 109/125A This is also listed as cost-beneficial in Appendix F. (($674,000+$333,000)-$100,000)
125C	Fire wrapping and recovery cables for 480VAC switchgear rooms and protection of containment spray cabling.	$654,000	SAMA 109/125A and 125B are assumed not implemented. (($674,000+$333,000+$397,000)-$750,000)(2)

(1) Basis for values in Table from Appendix F of the ER:

$599,000 – *Section F.6.23 (Net Value)*
$907,000 – Net Value derived for RAI based on Averted Cost Risk Values and SAMA costs.
$674,000 – Section F.6.23 (Averted Cost Risk)
$333,000 – Section F.6.28 (Averted Cost Risk-125B)
$100,000 – Section F.6.28 (Estimated Cost-125B)
$654,000 – Net value derived for RAI based on Averted Cost Risk Values and SAMA costs.
$397,000 – Section F.6.28 (Averted Cost Risk-125C) assuming SAMAs 109 and 125B implemented.
$750,000 – Section F.6.28 (Estimated Cost-125C)

(2) A conservative estimate of the benefit of SAMA 125C, if implemented alone, can be taken from Appendix F of the Environmental Report (ER). The total averted cost-risk of SAMA 109/125A ($674,000), 125B ($333,000), and SAMA 125C ($397,000) is $1,404,000. This is greater than the cost, $750,000, estimated in Appendix F of the Environmental Report (ER). The results of the assessment indicate that SAMA 125C is cost-beneficial if either SAMA 109 or 125B is not implemented. However, as indicated in *Section F.6.28 of the Appendix F of the ER.* SAMA 125C is not cost beneficial if SAMA 109/125A and 125B are implemented.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

4g) SAMA 127, regarding operator training (Section F.6.30), is indicated to be important to implement even though a specific net value is not identified. However, the improvements envisioned as part of this SAMA are not clear. Provide additional information regarding how the current training practices/programs would be modified as part of this SAMA, and how the benefits would be quantified.

AmerGen Response:

The current PRA training program provided to the operating crews is considered to be appropriate and acceptable in both structure and general content.

SAMA 127 involves the updating of the PRA training curriculum to reflect the importance of the operator actions, systems, structures, and components from the latest Oyster Creek PRA model. These important operator actions, systems, structures, and components are slightly different than those identified in the previous PRA update. They reflect the latest importance changes as a result of data updates, procedure changes, hardware modifications, plus updated modeling such as inclusion of a conditional LOOP event given a LOCA or transient plant challenge.

The original IPE identified that operator training on PRA insights enhances safety and reduces risk. This was included in the SAMA alternatives to highlight this insight. No explicit credit is applied due to this SAMA although some focused or "across-the-board" reductions in operator error rates could be estimated[1]. Such exercises would be judgmental. In most cases, the changes in risk profile for the modest changes in the training program would support the result that the training SAMA is considered cost-beneficial. As such, it is concluded that the SAMA regarding continued training of operators on the latest PRA results is cost beneficial. It is not judged necessary to speculate on the magnitude of benefit other than to define the benefit as universally positive.

[1] It is noted that incorporation of an explicit benefit associated with the revised training by reducing the HEPs would result in reducing the benefit attached to other SAMAs. This was not done for the Appendix F of the ER due to the speculative nature of the HEP reductions.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

4h) The evaluations of SAMAs 130 and 134 (Sections F.6.33 and F.6.36) make use of Figure 7 of Section 5.1 of the Oyster Creek IPEEE. The validity of this figure was questioned by the U.S. Nuclear Regulatory Commission staff during review of the IPEEE submittal, and it appears that the frequency of high winds could be underestimated by one to two orders of magnitude (the frequency of wind speeds exceeding 168 miles per hour is 5E-7 per year in the IPEEE versus a staff estimate of 7E-06 per year. The frequency of wind speeds exceeding 117 miles per hour is about 5E-6 per year in the IPEEE versus a staff estimate of 1E-03 per year). Explain how the evaluation of these two SAMAs (including the baseline risk from high winds and the risk reduction for each SAMA) would be affected if more appropriate values are used for the frequency of high winds.

AmerGen Response:

The PRA model evaluates the probability of high wind related damage as it may result in both initiating events (e.g., loss of offsite power (LOOP)) and consequential damage. For the most recent PRA update, the LOOP frequency evaluation included an industry data based evaluation of the probability of LOOP caused by severe weather and high winds.(1) Failure of the combustion turbines and fire pumps were included as dependent failures for high wind conditions as they are housed in structures that are less rugged with regard to wind forces.

In the base model, both the failure of the CTs and fire pumps accompany LOOP in extreme weather scenarios. The total failure probability of this case is the product of the LOOP initiating event frequency, 4.62E-2/yr, and the conditional probability of extreme weather, 4E-2 determined from nuclear power plant data, is to represent hurricanes and tornadoes. Thus, the probability of this set of failures is 1.8E-3/yr in the baseline PRA model. This data led to frequencies used in the baseline PRA that are significantly higher than those frequencies cited in the Oyster Creek IPEEE figure (Figure 7 of Section 5) which is questioned by the NRC. Therefore, the maximum potential impact consistent with operating experience data is included in the base PRA.

For example, Oyster Creek uses a frequency of 1.8E-3/yr to represent extreme weather at Oyster Creek (winds greater than 85 mph). The IPEEE figure in question would give a value of approximately 2E-4/yr. (The IPEEE figure in question was not used in the baseline PRA.)

The wind speed and its associated frequency must correspond to the cost of the structural enhancements used to represent the wind capacity of the buildings after the SAMA implementation. The cost of construction of safety related structures was considered so high as

(1) The Oyster Creek Base PRA model was assembled using information from EPRI and the NRC regarding severe weather and extreme weather frequencies that have led to LOOP events at nuclear power plants.

This data provided the basis for assessing the frequency of extreme weather leading to both a LOOP and failure of the buildings for the CTs and the Fire Protection pumps.

to be cost prohibitive. Therefore, the assessment examined the improvement (benefit) to be achieved by structural enhancements that correspond to building design capability for wind speeds in excess of 115 mph. To represent the realistic building capability for such designs, the frequency of the events was assessed as 1E-4/yr which corresponds approximately to 115 mph when using the slope of the frequency versus wind speed graphs anchored by the point 1.8E-3/yr at 85 mph.

For the evaluation of the SAMA, the noted Figure 7 from the IPEEE was used only for guidance in scaling down the frequency of events as wind speed increased. (The slope of the curve is similar between the IPEEE curve and that referenced by the NRC in the SER.) This was to mock-up the effect of improved building wind capability as a result of the SAMA as would be expected if the buildings were upgraded to withstand higher wind forces. The SAMA documentation did not specify exact design conditions but rather noted the intent would be to upgrade the buildings. The SAMA used the noted Figure 7 to scale the failure probability of structures to reflect the benefit of enhanced design. A value of 115 mph was noted as a representative range to allow some consideration of flexibility in the final design. For this SAMA case, the conditional probability that extreme weather causes coincident failure of the CTs and the Fire Protection Pump building was reduced by a factor of 20 from 0.04 to 2E-3. This is an optimistic assessment of the benefit to be achieved by enhancing the structural capability of the buildings. This would make the frequency of an extreme wind failure of offsite power, CTs, and fire pumps approximately 1E-4/yr (i.e., 4.62E-2/yr*2E-3). For structural capacity in the range of 115 mph, the NRC value quoted for 117 mph is 1E-3/yr. However, the higher the frequency of building failure assumed after the SAMA implementation, then the lower the calculated benefit.

Currently, the baseline risk profile for Oyster Creek is set by the relatively low building wind capabilities of the fire protection pump house and the Combustion Turbine structures. The use of the noted Figure 7 of Section 5.1 of the Oyster Creek IPEEE is only used to determine the maximum increase in benefit to be achieved if the structures are upgraded to withstand higher wind speeds.

The SAMA benefit is evaluated with an <u>assumed</u> change in LOOP frequency plus building failure frequency from the current base of 1.8E-3/yr to approximately 1E-4/yr (i.e., 4.62E-2/yr * 2E-3); the reduction in frequency is based on the assumption that the structural capacities are enhanced. This represents a reduction in failure frequency of a factor of approximately 20. If the frequency associated with the lower end of the hazard curve (117 mph) suggested by the NRC is used the benefit would be reflective of only a reduction in the frequency from 1.8E-3/yr to 1E-3/yr (less than a factor of 2 reduction in this risk scenario). (It is noted that the larger the assumed reduction in damage frequency, the higher the net value of the SAMA.)

A comparison of the benefit (cost risk averted) and net value for the evaluation of a SAMA to enhance structural capabilities is provided for SAMA 130 in Tables 4h-1 through 4h-3 and for SAMA 134 in Tables 4h-4 through 4h-6.

For SAMA 130, it is calculated in Table 4h-1 that the net value shown in the ER Appendix F of $147,000 may be optimistic compared with the net value estimate used for extreme weather frequency at 115 mph[(1), (2)] cited by the NRC of 1.0E-3/yr in Table 4h-2.

For SAMA 134, it is found in Table 4h-4 that the net value shown in the ER Appendix F is $288,000 and this may be optimistic compared with the net value estimate used for extreme weather frequency at 115 mph[(1), (2)] cited by the NRC of 1.0E-3/yr in Table 4h-5.

The table below is a summary comparison of the net value results for the two SAMAs showing that the net values quoted in the ER may be optimistic, i.e., may overstate the benefit when compared with estimates using the NRC estimates of the degree of improvement.

SUMMARY COMPARISON

SAMA	Description	Net Value	
		SAMA Evaluation (ER App F)	NRC Recommended Revised Evaluation
SAMA 130	Protect CTs from Extreme winds	$147,000	-$202,000
SAMA 134	Upgrade Fire Pump House for better performance under extreme winds	$288,000	-$58,000

It is judged that the assumptions applied to the benefit to be gained by upgrading the CT building and Fire Pump building may result in over estimating the benefit to be gained by these SAMAs. This insight can be supplied to the decision makers, however, no change to the base line SAMA evaluation is considered necessary.

(1) Use of the 115 mph wind speed as the step function where the two subject buildings fail would result in a lower benefit and net value for the SAMAs. It is judged more appropriate to represent the effect of a building designed for 115 mph to have a realistic wind capability that is higher than 115 mph. As such, the benefit to be achieved by the building design for 115 mph is modeled as higher than suggested by the NRC specified curve.

(2) It should be noted that a building designed for 115 mph is realistically capable of surviving for higher wind speeds, such that the benefit of a building designed for 115 mph should realistically use a failure frequency at a higher wind speed.

Table 4h-1

SAMA 130
COMPARISON SUMMARY OF STRUCTURAL IMPROVEMENT EFFECT ON COST RISK AVERTED AND NET VALUE

Building Condition	Wind Capability (mph)	Frequency of LOOP and Bldg. Failure (per yr)	Cost of Implementation ($)	Cost-Risk Averted ($)	Net Value ($)
Current Structure	85	1.8E-3	--	--	--
Significant Upgrade	115	1.0E-4	600,000	747,000	147,000
Safety Related Upgrade	168	5.0E-7	Not evaluated. Considered prohibitively expensive	--	--

Table 4h-2

SAMA 130
COMPARISON SUMMARY OF STRUCTURAL IMPROVEMENT EFFECT ON COST RISK AVERTED AND NET VALUE USING NRC ESTIMATES OF WIND SPEED

Building Condition	Wind Capability (mph)	Frequency of LOOP and Bldg. Failure (per yr)	Cost of Implementation ($)	Cost-Risk Averted ($)	Net Value ($)
Current Structure	85	1.8E-3	--	--	--
Significant Upgrade	115	1.0E-3	600,000	398,000	-202,000
Safety Related Upgrade	168	7.0E-6	Not evaluated. Considered prohibitively expensive	--	--

Table 4h-3

SAMA 130
COMPARISON SUMMARY OF STRUCTURAL IMPROVEMENT EFFECT ON COST RISK AVERTED AND NET VALUE (IPEEE VALUES)

Building Condition	Wind Capability (mph)	Frequency of LOOP and Bldg. Failure (per yr)	Cost of Implementation ($)	Cost-Risk Averted ($)	Net Value ($)
Current Structure	85	1.8E-3	--	--	--
Significant Upgrade	115	5.0E-6[1]	600,000[1]	--[1]	--[1]
Safety Related Upgrade	168	5.0E-7	Not evaluated. Considered prohibitively expensive	--	--

[1] As noted by NRC, this estimate of the frequency of wind speed in excess of 115 mph is considered incorrect and is <u>not</u> used. Rather a value of 1E-4 is used which will result in an overestimate of the benefit.

Table 4h-4

SAMA 134
COMPARISON SUMMARY OF STRUCTURAL IMPROVEMENT EFFECT ON COST RISK AVERTED AND NET VALUE

Building Condition	Wind Capability (mph)	Frequency of LOOP and Bldg. Failure (per yr)	Cost of Implementation ($)	Cost-Risk Averted ($)	Net Value ($)
Current Structure	85	1.8E-3	--	--	--
Significant Upgrade	115	1.0E-4	150,000	438,000	288,000
Safety Related Upgrade	168	5.0E-7	Not evaluated. Considered prohibitively expensive	--	--

Table 4h-5

SAMA 134
COMPARISON SUMMARY OF STRUCTURAL IMPROVEMENT EFFECT ON COST RISK AVERTED AND NET VALUE USING NRC ESTIMATES OF WIND SPEED

Building Condition	Wind Capability (mph)	Frequency of LOOP and Bldg. Failure (per yr)	Cost of Implementation ($)	Cost-Risk Averted ($)	Net Value ($)
Current Structure	85	1.8E-3	--	--	--
Significant Upgrade	115	1.0E-3	150,000	92,000	-58,000
Safety Related Upgrade	168	7.0E-6	Not evaluated. Considered prohibitively expensive	--	--

Table 4h-6

SAMA 134
COMPARISON SUMMARY OF STRUCTURAL IMPROVEMENT EFFECT ON COST RISK AVERTED AND NET VALUE (IPEEE VALUES)

Building Condition	Wind Capability (mph)	Frequency of LOOP and Bldg. Failure (per yr)	Cost of Implementation ($)	Cost-Risk Averted ($)	Net Value ($)
Current Structure	85	1.8E-3	--	--	--
Significant Upgrade	115	5.0E-6(1)	150,000(1)	--(1)	--(1)
Safety Related Upgrade	168	5.0E-7	Not evaluated. Considered prohibitively expensive	--	--

(1) As noted by NRC, this estimate of the frequency of wind speed in excess of 115 mph is considered incorrect and is <u>not</u> used. Rather a value of 1E-4 is used which will result in an overestimate of the benefit.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

4i) In the evaluation of SAMA 132 (Section F.6.34), a value of 0.5 was assumed for the potential for a spurious trip of the combustion turbines, and the SAMA was estimated to have only a slightly negative net value. If the potential for a spurious trip was assigned a value of 0.4, this SAMA would be cost beneficial. Provide additional justification for the 0.5 value.

AmerGen Response:

SAMA 132 evaluates the procedural change to allow alignment of the running Combustion Turbines (CTs) to Oyster Creek without waiting for a coast down period. It incorporates an estimate of possible spurious trip of the CTs during this LOOP event and resulting transfer process.

The 0.5 value is based on judgment. There is no currently available information to suggest any alternate value would be more appropriate. The 0.5 estimate minimizes the maximum error in the calculation. In addition, this SAMA is listed in Section F.6.39.2 of Appendix F of the ER as a marginally non-cost-beneficial alternative. Also, Section F.7, Sensitivity, shows two separate quantifications wherein varying aspects of the calculation yields a cost-beneficial finding for this SAMA. Table F.8-3 in Appendix F of the ER identifies that SAMA 132 is cost beneficial when considering the 95th percentile CDF.

Clearly, this alternative is borderline and any number of parametric changes could result in cost-beneficial results. It is judged that Appendix F of the Environmental Report (ER) appropriately characterizes the net value associated with SAMA 132 for use by the decision makers.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

5a) In evaluating combinations of cost-beneficial SAMAs in Section F.6.39.1, the SAMAs appear to have been divided into four unique groups (Group1 - SAMAs 91, 99, 109; Group 2 - SAMA 125B; Group 3 - SAMA 127; and Group 4 - SAMAs 130 and 134), and the optimum SAMA within each group (judged in terms of maximum net value) was then identified. This resulted in a set of four optimum and unique SAMAs (i.e., SAMAs 109, 125B, 127, and 134). However, the combined effect of implementing these four SAMAs was not provided. Provide an assessment of the combined benefit of implementing the four high priority SAMAs identified.

AmerGen Response:

Background

Table F.8-1 from Section F.8.2 in Appendix F of the ER summarized the seven (7) SAMAs that resulted in potential for a positive cost benefit if the identified SAMA is implemented and a best estimate analysis is performed.

Table F.8-1
Cost Beneficial SAMAs When Considered Separately[(1)]

SAMA No.	Description	Best Estimate Net Value (20 Year Life)
91	Allow 4160V AC Bus IC and ID cross tie	$28,000
99	Provide an alternate method for IC shell level determination	$524,000
109	Portable DC battery charger to preserve IC and EMRV operability along with adequate instrumentation	$599,000
125B	Reduce fire impact in dominant fire area of the 480V AC switchgear via a circuit breaker addition	$233,000
127	Increased training on the systems and operator actions determined to be important from the PRA.	Judgment
130	Protect combustion turbines	$147,000
134	Upgrade fire pump house building integrity so that fire system would be capable of withstanding a severe weather event.	$288,000

(1) It is noted that SAMA 125 related to reduction in the fire induced CDF in the 480V AC switchgear room is found cost beneficial with or without SAMA 109 implementation. If SAMA 109 is not implemented, the more capital intensive change 125C should be considered.

As pointed out in Section F.6.39, it is found that certain cost beneficial SAMAs have "shadowing" effects on other SAMAs such that when they are implemented the other SAMAs become significantly less important. For example, the SAMAs that are found not cost beneficial when SAMAs 109 and 134 are implemented are 91, 99, and 130.

The priority for SAMA implementation based solely on the maximum net value is:

Priority	SAMA No.	Description	Best Est. Net Value (20 yr. Life)
1	109	Portable DC Battery Charger to Preserve IC and EMRV Operability Along With Adequate Instrumentation	$599,000
2	134	Upgrade Fire Pump House Structural Integrity	$288,000
3	125B	480V AC switchgear circuit breaker addition(1)	$233,000
4	127	Operator Training	Judgment

(1) It is noted that SAMA 125B related to reduction in the fire induced CDF in the 480V AC switchgear room is found cost beneficial with or without SAMA 109 implementation. If SAMA 109 is not implemented, the more capital intensive change 125C should be considered.

Calculation

The total estimated net value for these four SAMAs implemented together can be determined as shown below by comparing the combined cost of the SAMAs with the averted cost risk.

SAMA costs:

SAMA	Cost of SAMA
109	$ 75,000
125B	$100,000
127	$ 50,000
134	$ 150,000
Total	$375,000

SAMA averted cost-risk:

The averted cost-risk is a summation of the following:

- The averted cost-risk associated with the fire SAMA (125B) determined from Section F.6.28 of the ER as $333,000.

- The averted cost-risk of the other SAMAs evaluated with the base model (CDF is decreased from 1.05E-5/yr to 6.22E-6/yr)

Overall Cost Benefit of SAMAs (SAMA 109, 127, 134)
Using MACCS Results By Release Category

Calculation Description	Total	Release Category									
		Intact	L-LL/E, L-LL/I	L-LL/L	M/E	M/I	M/L	H/E	H/I	H/L	BOC
Baseline Freq. (per yr.)	1.05E-05	2.71E-06	3.38E-06	1.96E-07	9.99E-07	1.66E-06	1.67E-09	5.48E-07	7.86E-07	2.10E-07	3.23E-08
SAMA Freq. (per yr.)	6.22E-06	2.12E-06	1.05E-06	7.30E-08	5.16E-07	1.47E-06	1.67E-09	3.27E-07	4.53E-07	2.10E-07	3.23E-08
SAMA Dose-Risk (Person Rem/yr.)	1.99E+01	5.29E-02	4.22E+00	1.08E-02	2.98E+00	6.17E+00	5.90E-03	2.59E+00	1.90E+00	1.58E+00	4.01E-01
SAMA OECR ($/yr.)	6.73E+04	2.10E+01	1.24E+04	8.83E+00	9.85E+03	1.86E+04	1.61E+01	1.23E+04	4.93E+03	7.91E+03	1.17E+03

Averted Cost-Risk
Combined C/B SAMA-Base

Base Case: Cost-Risk for Oyster Creek (site)(1), (2)	Cost-Risk for Oyster Creek With SAMA Changes	Averted Cost-Risk
$4,462,000	**$2,526,000**	**$1,936,000**

(1) Present Value Cost-Risk. The derivation of the present value cost-risk includes the OECR plus the other contributors to cost-risk described in Section F.3 of the main report.

(2) Includes a factor of two increase to account for external events.

The summation of the averted cost-risks is as follows:

SAMA	Averted Cost-Risk ($)
109, 127, 134	1,936,000
125B	333,000
Total	2,269,000

Summary

Total net value (SAMAs 109, 125B, 127, and 134):

= Cost Risk Averted – Cost of SAMA
= $2,269,000 - $375,000
= $1,894,000

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

5b) An evaluation of synergies between non-cost-beneficial SAMAs is provided in Section F.6.39.2. The SAMAs considered in this evaluation were said to have been selected because they are close to being cost beneficial (i.e., have net values between 0 and -$50 thousand) and could potentially become cost-beneficial in combination with other SAMAs. However, for all but two of the SAMAs considered, the averted cost risk for each SAMA is essentially zero (the small negative net value is due to a cost of $50 thousand and essentially a zero benefit). Thus, combinations of these SAMA would not be expected to be cost-beneficial. Only two of the subject SAMAs (106 and 132) have a substantive benefit. Although these two SAMAs were considered as part of "Combination B2," they may be of more value if evaluated in concert with the four optimum cost-beneficial SAMAs identified in F.6.39.1. Justify that these two SAMAs would not be cost-beneficial if implemented in conjunction with the four cost-beneficial SAMAs.

AmerGen Response:

For this sensitivity assessment, the "baseline" model is revised to represent the plant under the conditions where the four cost-beneficial SAMAs are assumed implemented. Therefore, the revised "baseline" model includes SAMAs 109, 125B, 127, and 134. The additional SAMAs evaluated in this sensitivity case are the combined implementation of SAMAs 106 and 132.

SAMA No.	SAMA Description	Cost of Implementation ($)
106	Revise ABN-19 to include guidance to implement a <90°F/hr cooldown as soon as possible following a loss of RBCCW to supplement protection of recirculation pump seals by reducing RPV pressure.	50,000
132	Revise operating procedures to allow switching of the CTs to Oyster Creek while running.	50,000
Total		100,000

Table 5B-1 shows the results of additional sensitivity cases.

Table 5B-1

ADDITIONAL SAMA 106 AND 132 SENSITIVITY CALCULATIONS

SAMA Case	SAMA Cost	CDF (yr)	Averted Risk-Cost	Net Value
Revised Base	(1)	6.22E-6	(1)	(1)
106	$50,000	6.16E-6	$30,000	-20,000
132	$50,000	6.12E-6	$50,000	0
106 and 132	$100,000	6.05E-6	$84,000	-$16,000

(1) This case represents the revised baseline plant model wherein the four cost-beneficial SAMAs (109, 125B, 127, 134) are implemented.

These calculations show that SAMA 106 and 132 do not become cost-beneficial if the cost-beneficial SAMAs are implemented. Note that SAMA 132 is clearly a borderline case. This is reflected in the sensitivity cases in Appendix F of the ER as well as the discussion relating to RAI 4i, above.

SAMA 125B addresses fire risk and, per Section F.6.28 of the main report, since the main PRA model does not include external events, a modified base model was used to evaluate fire risk. Separate quantification of the surrogate fire model showed a lesser benefit for these cases because they do not provide significant benefit in the dominant fire scenarios.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

5c) Seven cost-beneficial SAMAs were identified in the baseline analysis (SAMAs 91, 99, 109, 125B, 127, 130, and 134). However, based on the evaluation of various combinations of SAMAs in Section F.6.39, and the discussion in Section F.6.39.3, it appears that only four of these SAMAs will receive any further consideration for implementation (SAMAs 109, 125B, 127, and 134). The assessments in Section F.6.39.1 indicate that the remaining three SAMAs would no longer be cost-beneficial if the four priority SAMAs are implemented, but this assessment does not address the impact of uncertainties (i.e., whether the three unimplemented SAMAs would remain non-cost-beneficial if uncertainties were considered). From the information provided, these three SAMAs may remain cost-beneficial even after implementation of the four priority SAMAs when uncertainties are considered. Provide an assessment of the upper bound net values associated with implementing the remaining cost-beneficial SAMAs (SAMAs 91, 99, and 130) assuming that the four priority SAMAs are implemented.

AmerGen Response:

As discussed in Section F.7.2 of Appendix F of the ER the effect of parametric uncertainties can be reasonably bounded by multiplying the averted cost-risk by a factor of 2.5 which reflects the upper bound of the CDF distribution relative to the point estimate values (approximately the mean) used elsewhere in the analysis.

For this sensitivity case, it is assumed that the following SAMAs are implemented:

SAMA
109
125B
127
134

For this sensitivity assessment, the baseline model is revised to represent the plant under the conditions where the above four SAMAs are assumed implemented. The additional SAMAs investigated for this case represent the combined implementation of SAMAs 91, 99, and 130.

SAMA	Cost of Implementation
91	$90,000
99	$150,000
130	$600,000
Total	$840,000

Table 5C-1 shows the impact of SAMA 91, 99, and 130 if they are implemented individually and also when all three are implemented together with the revised PRA model given that the four SAMAs (109, 125B, 127, and 134) are implemented as part of the revised baseline.

Table 5C-1

ADDITIONAL SAMA 91, 99, AND 130 SENSITIVITY CALCULATIONS

SAMA Case	SAMA Cost	Best Estimate			Net Value – 95% Upper Bound
		CDF (yr)	Averted Cost-Risk	Net Value	
Revised Base	(1)	6.22E-6	(1)	(1)	(1)
91	$90,000	6.11E-6	$54,000	-$36,000	$45,000
99	$150,000	5.97E-6	$96,000	-$54,000	$90,000
130	$600,000	5.72E-6	$228,000	-$372,000	-$30,000
91, 99, 130	$840,000	5.47E-6	$336,000	-$504,000	$0

(1) This case represents the revised baseline plant model wherein four SAMAs (109, 125B, 127, and 134) are implemented. Benefit is determined based on further improvement.

As can be seen from Column 5 in Table 5C-1, these SAMAs remain non-cost beneficial for the realistic, best estimate, case even with implementation of the four SAMAs (109, 125B, 127, and 134). From the last column of Table 5C-1, the net value cases are positive for SAMA 91 and SAMA 99 when the 95% upper bound CDF is used in conjunction with the revised base case. This is consistent with Tables F.7-2 and F.7-3 of the Appendix F of the Environmental Report wherein these SAMAs are shown to have positive net values under the sensitivity conditions (i.e., 3% RDR, 95% CDF).

SAMA 125B addresses fire risk and, per Section F.6.28 of the main report, because the base PRA model does not include external events, a modified base model was used to evaluate fire risk. Separate quantification of this model showed a similar benefit for these cases and no best estimate evaluations of SAMAs 91, 99, or 130 were classified as cost-beneficial.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

6a) Two additional SAMAs have a positive net value when a 3 percent discount rate is used (SAMAs 10 and 132), and five additional SAMAs (beyond those in the 3 percent case) have a positive net value if the benefits are increased to represent the upper bound of the uncertainty assessment (SAMAs 84, 106, 124, 125C, and 138). Based on a staff assessment, SAMA 129 may also be cost-beneficial when uncertainties are considered (the results for SAMA 129 were omitted from Table F.7-3). A brief, qualitative discussion of each of the seven "new" cost-beneficial SAMAs is provided in Table F.7-4, but the thrust of the arguments is that the 95th percentile case is extreme, or that in the case of two SAMAs there could be competing effects. Even then however, four of these additional SAMAs appear cost-beneficial and have no competing effects. Provide an assessment of the upper bound net values associated with implementing the eight additional SAMAs (SAMAs 10, 84, 106, 124, 125C, 129, 132, and 138), assuming that the four priority SAMAs are implemented.

AmerGen Response:

The upper bound new value for these individual SAMAs (10, 84, 106, 124, 125C, 129, 132, and 138) and their combination are recomputed assuming the implementation of SAMAs 109, 125B, 127, and 134.

For this sensitivity assessment, the "baseline" model is revised to represent the plant under the conditions where the four SAMAs (109, 125B, 127, and 134) are assumed implemented. Two types of comparisons are performed.

- Each of the individual SAMAs is evaluated separately and the best estimate averted cost-risk plus the net values for the best estimate and upper bound are reported in Table 6A-1.
- All of the suggested SAMAs are combined into a single plant modification and the cost of implementation is the sum of each individual SAMA. The SAMAs for this case represent the combined implementation of SAMA 10, 84, 106, 124, 125C, 129, 132, and 138. The best estimate averted cost-risk plus the net value for the best estimate and upper bound are reported in Table 6A-1.

The results in the last column of Table 6A-1 can be compared with the results from Table F.7-3 of the ER.

Table 6A-1

ADDITIONAL SAMA SENSITIVITY CALCULATIONS

SAMA Case	SAMA Cost	Best Estimate			Net Value – 95% Upper Bound
		CDF (yr)	Averted Cost-Risk	Net Value	
Revised Base	(1)	6.22E-6	(1)	(1)	(1)
10	$1,000,000	4.75E-6	$728,000	-$272,000	$820,000
84	$150,000	6.19E-6	$14,000	-$66,000	-$45,000
106	$50,000	6.16E-6	$30,000	-$20,000	$25,000
124	$150,000	(3)	$84,000	-$66,000	$60,000
125C(2)	$750,000	6.22E-6	$391,000	-$359,000	$227,000
129	$100,000	5.81E-6	$72,000	-$28,000	$80,000
132	$50,000	6.12E-6	$50,000	0	$75,000
138	$780,000	5.96E-6	$120,000	-$660,000	-$480,000
10, 84, 106, 124, 125C, 129, 132, 138	$3,030,000	3.95E-6	$984,000	-$2,046,000	-$570,000

(1) This case represents the revised baseline plant model wherein the four SAMAs (109, 125B, 127, 134) are implemented. Benefit is determined based on further improvement from the revised baseline.

(2) Evaluated with base model modified to include SAMAs 109, 125B, 127, and 134 plus the dominant fire scenarios from the IPEEE. Because SAMA 125C involves a fire related mitigation measure, no impact on the internal events risk profile results.

(3) Seismic Scenario; evaluated separately since Base PRA does not include seismic events. SAMA 124 addresses a specific seismic scenario. Because the base PRA model does not include external events, this SAMA is assessed separately. The values reported for this SAMA are calculated from IPEEE scenarios. These scenarios involve a block wall failure leading to the loss of 125 VDC.

SAMA 109 addresses alternate DC charging and would be ineffective in this seismic scenario. SAMA 125B addresses fire scenarios independent of seismic events. SAMA 134 addresses high wind failures which represent initiators independent of seismic events. SAMA 127 addresses across-the-board maintenance of operator reliability and is not specifically credited for operator error-rate calculation. Therefore, implementation of the cost-beneficial SAMAs would have a minimal impact on the seismic scenarios related to SAMA 124. Values reported for SAMA 124 in Table 6A-1 are those derived in Appendix F of the ER.

Conclusion

As can be seen, none of the individual SAMAs or the combination of all of these SAMAs become cost-beneficial under best estimate assumptions. Table F.7-3 of Appendix F of the ER report lists the SAMAs that may be cost beneficial when the 95% upper bound CDF is used. Each of the SAMAs that become cost-beneficial in Table 6A-1 under the 95% upper bound conditions are already listed as such in Table F.7-3 of Appendix F of the ER[1]. Note again that SAMA 132 is clearly a borderline case. This is reflected in the sensitivity cases in Appendix F of the ER as well as the discussion relating to RAI 4i, above.

Two SAMAs, SAMA 84 and SAMA 138, are both non-cost beneficial under the assumptions of Table 6A-1 using the 95% upper bound CDF. This is a difference relative to the assessment reported in Table F.7-3 of the ER.

No changes to the input to the decision makers regarding the efficacy of the SAMAs is judged to arise from these additional sensitivity cases except that SAMAs 84 and 138 would be clearly not cost beneficial even at the upper bound CDF if the cost beneficial SAMAs (109, 125B, 127, and 134) are implemented.

(1) SAMAs 128 and 129 were inadvertently omitted from Tables F.7-2 and F.7-3. The corrected pages are included in the enclosed pages of Enclosure 2.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

6b) Those SAMAs that were screened out in Phase I based on cost (Code C or F) were reassessed assuming a 3 percent discount rate. The summary table that provides a further evaluation of those SAMAs (Table F.7-1) includes all screened SAMAs except SAMAs 26 and 42. Confirm that these two SAMAs would not become potentially cost-beneficial, or provide a further evaluation of these SAMAs.

AmerGen Response:

SAMA 26 and 42 would not be cost-beneficial when re-assessed assuming a 3 percent discount rate.

SAMA 42

SAMA 42 consists of the following:

Enhancement of procedures directing the use of the Service Water system as a back up for 1) ESW and 2) EDG/ESW. Updated procedures and training on their use may improve the reliability of the cross-ties.

- ESW single train to SW crosstie exists design
- Look for SAMA that says

The Oyster Creek EDGs are air cooled; therefore, no benefit is developed for the cross tie to the EDGs.

In addition, currently, no procedure for DFP or SW to ESW cross tie exists. The benefits of more diverse options for ESW cooling were quantified for SAMA 18.[1] SAMA 18 is similar to SAMA 42 as it would allow service water or fire water to be redundant to ESW for support of the containment spray system. SAMA 18 is evaluated in Section F.6.3 and produced an $8,000 benefit. Assessment of system capabilities (i.e., flow rate, potential for water-hammer, etc.) and procedure modification would require an expenditure of at least $50,000 (plus design analysis to support the use of the cross tie), consistent with other procedure changes described in Table F-16 of the main report. Because of the small benefit, SAMA 42 was listed as "Cost Exceeds Benefit" in Table F-15 of the main report.

The sensitivity analysis in Section 7 of Appendix F of the ER shows that the variation in cost-risk is less than a factor of three (3) for the combination of 3% discount rate and use of upper bound CDF estimates. Therefore, for SAMA 42, which has a potential $8,000 cost-risk (benefit) and a cost of at least $50,000, a factor of three (3) or more increase in the cost-risk will not approach the estimated cost.

(1) SAMA 18: Cross-tie of fire water to containment spray heat exchangers; Improved ability to cool the residual heat removal heat exchangers.

SAMA 26

SAMA 26 involves supplemental air supply for the containment vent. However, Oyster Creek has dedicated air accumulators for containment venting AOVs in the hard pipe vent path. This makes the availability of additional redundant air supplies of negligible benefit and no further sensitivity is considered necessary.

Oyster Creek operates at power with the containment inerted for an overwhelming fraction of the time. Relative to combustible gas venting considerations of SAMA 26, the containment inerted condition precludes any significant potential net value from costly modifications to provide additional means of combustible gas venting.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

7. A portion of the first paragraph in F.7.2 is missing. Provide the missing portion.

AmerGen Response:

F.7.2 95th PERCENTILE PRA RESULTS

The results of the SAMA analysis can be impacted by implementing conservative values from the PRA uncertainty distribution. If the best estimate failure probability values are consistently lower than the "actual" failure probabilities, the PRA model would underestimate plant risk and yield lower than "actual" averted cost-risk values for potential SAMAs. Re-assessing the cost benefit calculations using the high end of the failure probability distribution is a means of identifying the impact of having consistently underestimated failure probabilities for plant equipment and operator actions included in the PRA model.

This change is reflected in the sheets in Enclosure 2 of this submittal.

NRC Letter Dated: 11/9/2005
NRC RAI SAMA

8. Section F.5.2 provides a very brief statement about implementation costs. Various references are provided regarding implementation costs, including cost estimates from other SAMA evaluations. However, for several SAMAs, the explanation for the cost estimate is not provided, nor are details for the modification. Provide a brief explanation for the cost estimate (i.e., provide more details to support the cost, for example, see SAMA 10) for Phase II SAMAs 7, 100, 108, 109, 110, 111, 112, 124, 125B, 133, 134, 136, and 138.

AmerGen Response:

Table 8-1 is a list of SAMA items questioned and available details regarding implementation costs.

Table 8-1

SUMMARY OF IMPLEMENTATION COST ESTIMATES

RAI No.	SAMA Item	Description	Cost Estimate	Cost Estimate Basis
3a	Not included in SAMA Report	Automatic actuation of bypass valve to increase CRD injection to the RPV	$250,000	This item is new and was not previously addressed. Providing for automatic operation of the CRD Bypass valve V-15-30 would require the installation of a 2" MOV, a programmable controller to actuate the valve and input for power and signals to determine when to open the valve. The engineering for this modification is conservatively estimated at $100K and the materials and installation cost at $150K. It is felt that the negative risks incurred by the potential failure modes of an automatic valve would outweigh any positive benefits. If the modification was limited to providing remote operation of the valve in the Control Room, the programmable controller and signal inputs could be eliminated; however, the costs of running control cabling into the Room would have to be considered. The cost of the modification would be about $150K.
8	SAMA #10	Passive Overpressure Relief for Primary Containment	$1,000,000	System Manager estimate using engineering judgment. The Hardened Vent system would need to be completely redesigned because Oyster Creek uses the Nitrogen Purge supply line as the Hardened Vent line. This line is normally lined up to the N2 Supply System and a passive arrangement would require the need for system redesign. The original system costs were about $2M in the early 1990s. Therefore $1M in 2005 for a significant redesign and the associated regulatory costs is considered to be conservatively low.

Table 8-1

SUMMARY OF IMPLEMENTATION COST ESTIMATES

RAI No.	SAMA Item	Description	Cost Estimate	Cost Estimate Basis
8	SAMA #7	Enhance Alternate Injection Reliability	$500,000	System Manager estimate using engineering judgment. The additional piping, tie-ins and valves to allow this system to be used, together with the filtration system that would be required to prevent debris from plugging the Core Spray Spargers would be expected to cost at least $500K. It is unknown what the analysis would cost to evaluate the overall and long term effects of using salt water to cool the core and containment, but it is estimated that this analysis would cost at least $250K. Therefore, $500K for this modification is considered to be conservatively low.
8	SAMA #100	Connect SBO transformer to both AC divisions	$500,000	System Manager estimate using engineering judgment. The Engineering for this modification is expected to cost at least $100K. The new breaker and cubicle and modifications to install would cost at least $100K. The new instrumentation and modification to install would cost at least $100K. The cable installation from the SBO Transformer to the 1A switchgear would cost at least $200K. Therefore, a total cost of $500K for this modification is considered to be conservatively low.

Table 8-1

SUMMARY OF IMPLEMENTATION COST ESTIMATES

RAI No.	SAMA Item	Description	Cost Estimate	Cost Estimate Basis
8	SAMA #108	Reduce Fuel Zone Level Instrument Error Band	$500,000	System Manager estimate using engineering judgment. The relocation of the Fuel Zone Level Instrument reference leg closer to TAF is not feasible since no vessel penetrations exist lower than where the instrument is presently tapped in. It is possible that some analysis and modifications can be made to the Fuel Zone instruments or a new system with greater accuracy could be installed. The modifications required to accomplish these changes together with the analysis to determine what changes were needed is estimated to cost at least $500K.
8	SAMA #109	Portable DC Battery Charger to Preserve IC and EMRV Operability Along with Adequate Instrumentation	$75,000	This estimate came from the Monticello SAMA submittal. It is expected that the costs for this modification would be closer to $150K after engineering. Also if it was determined that more than one charger would be required to meet the intended functions, costs would increase. Therefore, the estimated cost of $75K for this modification is considered to be conservatively low.
8	SAMA #110	Delete High Drywell Pressure Signal From SDC Isolation	$75,000	System Manager estimate using engineering judgment. Oyster Creek already has the capability to bypass the Drywell pressure isolation signal from SDC as part of previous versions of the EOPs. To use this capability would require analysis and procedure changes as a minimum. Permanent changes to eliminate the trip of SDC would require a modification which would cost even more than $75K.

Table 8-1

SUMMARY OF IMPLEMENTATION COST ESTIMATES

RAI No.	SAMA Item	Description	Cost Estimate	Cost Estimate Basis
8	SAMA #111	Provide Alternate Drywell Spray Injection Source	$500,000	System Manager estimate using engineering judgment. The additional piping, tie-ins and valves to allow this system to be used, together with the filtration system that would be required to prevent debris from plugging the Containment Spray Spargers would be expected to cost at least $500K. It is unknown what the analysis would cost to evaluate the overall and long term effects of using salt water to cool the core and containment, but it is estimated that this analysis would cost at least $250K. Therefore, $500K for this modification is considered to be conservatively low.
8	SAMA #112	Intake Structure	$1,000,000	System Manager estimate using engineering judgment. This estimate includes the development of the programs to monitor the intake structure and associated components, additional maintenance to perform the associated monitoring and 0.5 man years/year for program oversight. The $1M cost estimate is for the 20 year extended life of the plant.
8	SAMA #124	Block Wall 53 Reinforcement	$150,000	System Manager estimate using engineering judgment. A walkdown of the wall in question was performed by the Structural Design group and this estimate is based on the engineering costs, materials and installation of the supports recommended.
8	SAMA #125B	Add a circuit breaker to bus 1B2 to protect the bus from cross-tie cable shorts initiated by fires in the 480 VAC "A" switchgear room	$100,000	System Manager estimate using engineering judgment. This estimate included a modification to add a disconnect breaker to the line between USS 1A2 and USS 1B2. Research into this issue since the SAMA Report was published indicates that the actual costs could be significantly more than the original estimates (>10%).

Table 8-1

SUMMARY OF IMPLEMENTATION COST ESTIMATES

RAI No.	SAMA Item	Description	Cost Estimate	Cost Estimate Basis
8	SAMA #133	Increase Hotwell Makeup Capability	$500,000 (A cost of $250,000 is used in the SAMA assessment.)	System Manager estimate using engineering judgment. This estimate is based on the cost to modify the present piping from the CST to the Hotwell such that gravity drain would allow a significantly greater volumetric flowrate. Since this piping is buried, a significant portion of the cost would be in digging up the piping and shoring up the excavation. Because of the amount of buried piping in this area, this is conservatively estimated to cost $300K based on past experience. The modification itself, including supports for larger piping, enlarged access through the Turbine Bldg wall and modifications to the Hotwells is estimated to be at least $200K. Therefore, a total cost estimate of $500K for this modification is considered to be conservatively low
8	SAMA #134	Upgrade Fire Pump House structural integrity	$150,000	System Manager estimate using inputs from the Structural Design group on potential enhancements to the structure. Detailed evaluation of this issue since the SAMA Report was published indicates the actual cost is closer to $350K.
8	SAMA #136	Provide alternate power to condensate transfer pumps	$100,000	System Manager estimate using engineering judgment. This estimate assumed that a spare conduit was available to an MCC powered from USS 1A2, and therefore only includes the cost of engineering and pulling a new cable. In the event that additional conduit needs to be installed, the cost estimate would increase.

Table 8-1

SUMMARY OF IMPLEMENTATION COST ESTIMATES

RAI No.	SAMA Item	Description	Cost Estimate	Cost Estimate Basis
8	SAMA #138	Protect transformers	$780,000	Estimate was made by the Electrical Design group using walkdowns and cost estimating tools. Walkdown was performed by design engineer responsible for cable installations. Estimate includes the cost of burying cable in new duct banks and installation of new conduit runs.

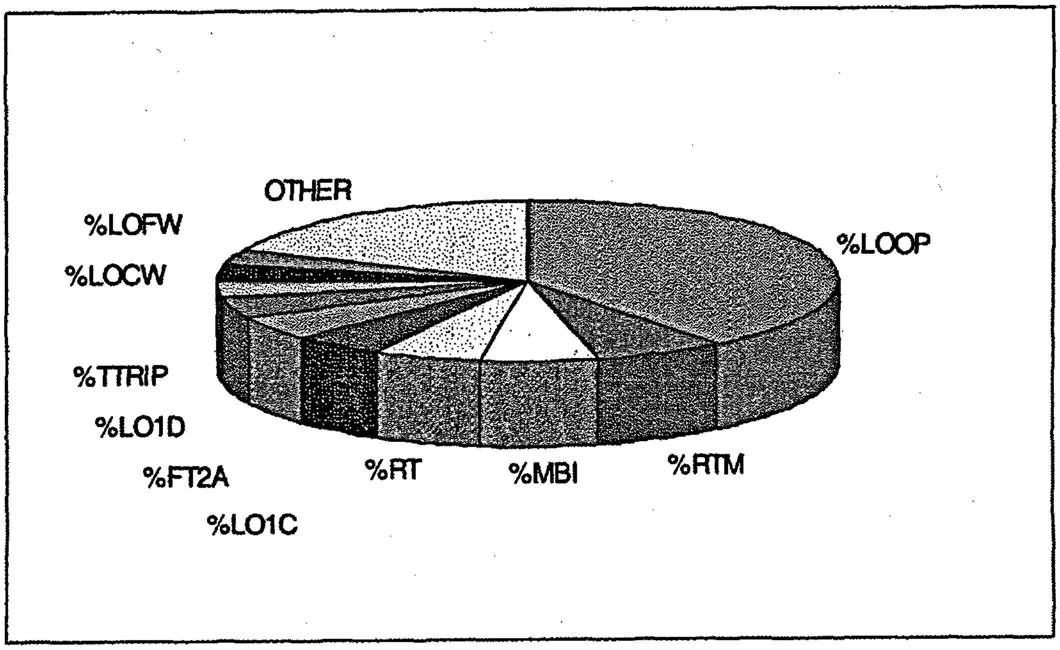
Enclosure 2

Replacement Pages

Note: The replacement pages are not sequentially numbered because they are formatted to be direct replacement pages for the corresponding pages in the original Oyster Creek License Renewal package. For information, there are 20 replacement pages in this Enclosure.

Figure F-2 Oyster Creek Contribution to CDF by Initiator (2004B Model)

Event Name	Description	% of CDF
%LOOP	LOSS OF OFFSITE POWER INITIATING EVENT	39.8%
%RTM	MANUAL SHUTDOWNS	6.5%
%MBI	MEDIUM LOCA - BELOW CORE INSIDE DRYWELL	6.2%
%RT	REACTOR TRIP	5.5%
%LO1C	LOSS OF 4160 VAC BUS 1C	5.0%
%FT2A	COND BAY AREA FEEDWATER FLOOD	4.7%
%LO1D	LOSS OF 4160 VAC BUS 1D	4.3%
%TTRIP	TURBINE TRIP	3.3%
%LOCW	LOSS OF CIRCULATING WATER	3.3%
%LOFW	LOSS OF FEEDWATER	3.2%
OTHER	REMAINING INITIATING EVENTS	18.2%



Notes:

(1) % of CDF is the Fussell-Vesely (FV) importance value for each initiator.

(2) The total contribution to CDF from %LOOP initiator and the conditional LOOP given a LOCA or transient is approximately 55.5%.

Quality of Model: The peer review process for fire PRAs is less well developed than for internal events PRAs. For example, no industry standard, such as NEI-00-02, exists for the structured peer review of a fire PRA. This may lead to less assurance of the realism of the model.

Overview of Oyster Creek Fire PRA Development

A Modified EPRI Fire Induced Vulnerability Evaluation (FIVE) assessment was developed for the IPEEE. A probabilistic process, based on the FIVE Methodology, was employed to evaluate plant fire areas. Fire areas were reviewed in progressive detail and once an area was shown to contribute less than 1E-6/yr to total core damage frequency, it was screened from further analysis. In addition, areas that were retained included significant conservatisms. Due to this approach, the IPEEE cannot be used to estimate a total fire CDF comparable to that used in the internal events portion of the PRA. Noting that probabilistic values in the Fire IPEEE are considered upper bound values due to conservatism and level of detail in the analysis, the IPEEE reports a core damage frequency of 7.7E-6/yr. The NRC notes that this value was revised to 1.9E-5/yr in their SER [F-36].

Areas that required detailed analysis are presumed to be those with the greatest risk significance. The detailed fire analysis included a probabilistic treatment of fire severity, fire detection and suppression, growth and propagation as well as equipment impacts. Eight fire areas required detailed analysis. These areas were:

- Reactor Building 51' Elevation (RB-FZ-1D)
- Reactor Building Main Floor – 23' Elevation (RB-FZ-1E)
- Cable Spreading Room – 36' Elevation (OB-FZ-4)
- Control Room – 46'6" Elevation (OB-FZ-5)
- "A" 480 VAC Switchgear Room (OB-FZ-6A)
- A and B Battery Room, Tunnel and Electric Tray Room – 35' Elevation (OB-FZ-8C)
- Turbine Building Basement (TB-FZ-11D)
- Battery Room South of 4160 VAC Switchgear (TB-FA-26)

Of these areas, two could not be screened within the IPEEE analysis:

- Cable Spreading Room – 36' Elevation (OB-FZ-4)
- "A" 480 VAC Switchgear Room (OB-FZ-6A)

The IPEEE report notes that these unscreened areas contribute 62.6% of fire CDF. Relative to potential SAMA, the IPEEE does not provide information regarding specific improvements to reduce risk related to these areas. However, AmerGen has reviewed these results for the purpose of the SAMA evaluation. Based on this review of the Oyster Creek fire IPEEE results, the following SAMAs have been identified for inclusion on the SAMA list:

Table F-15. Phase I SAMA Evaluation

NO.	SAMA TITLE	SAMA DESCRIPTION	SOURCE	PHASE I DISPOSITION	RETAINED FOR PHASE II ANALYSIS?
26	Supplemental Air Supply for the Containment Vent	The containment vent function is among the last resort methods currently specified in BWRs to remove heat from containment and control containment pressure under extremely adverse circumstances. The Dresden air compressors are required to support the containment vent function. The air compressors in tum require cooling, normally from TBCCW/SW. An alternative method to supply air to the vent valves for opening would be desirable if SW were to become inadequate.	Dresden Application for License Renewal [F-7]	D – Oyster Creek has dedicated air accumulators for containment venting AOVs in the hard pipe vent path. F – Oyster Creek does have secondary vent pathways that would be used to vent and purge combustible gases from containment. However, because Oyster Creek operates with an inerted containment atmosphere the NRC has previously determined that Mark I combustible gas venting is not risk significant. This is supported by the Oyster Creek PRA. Therefore, this plant modification would not be cost beneficial.	No
27	Supplemental Air Supply for Containment Vent Under SBO Conditions	The containment vent function is among the last resort methods currently specified in BWRs to remove heat from containment and control containment pressure under extremely adverse circumstances. Many plants require a long term source of air or nitrogen and a DC power source to allow venting in an SBO.	Dresden Application for License Renewal [F-7]	I – Oyster Creek has dedicated air accumulators for containment venting AOVs. Venting in an SBO is not a significant contributor because of the dominance by shorter term failures. SAMA 84 addresses handwheels for containment vent valves which would allow system operation in SBO.	No (See SAMA 84)
28	Demonstrate RCIC Operability Following Depressurization	This SAMA would increase the operators' options for injection with the vessel at low pressure. Given Monticello's ability to power the battery chargers with the 480v AC generator, the limiting factor for RCIC injection appears to be depressurization at HCTL. If it could be shown that a limited depressurization to about 100 psid could be performed and allow continued injection with RCIC, injection could be maintained for a longer period during an SBO.	Quad Cities Application for License Renewal [F-8]	N/A – Not applicable to Oyster Creek design. No RCIC at Oyster Creek.	No

Table F-15. Phase I SAMA Evaluation

NO.	SAMA TITLE	SAMA DESCRIPTION	SOURCE	PHASE I DISPOSITION	RETAINED FOR PHASE II ANALYSIS?
32	Use fuel cells instead of lead-acid batteries.	SAMA would extend DC power availability in an SBO.	Quad Cities Application for License Renewal [F-8]	I, F – Oyster Creek has diverse battery design presently. The system is already reliable. Evaluation of a portable DC charger is viewed as more beneficial. See Item 109. Also, note that the fuel cell option is new technology, never used in such a manner. It is judged expensive. A small, engine driven charger is considered a more cost-efficient and proven approach.	No (See SAMA 109)
33	Improve 4.16-kV bus cross-tie ability.	Enhance procedures to direct 4kV bus cross-tie. If this procedural step already exists, investigate installation of hardware that would perform an automatic cross-tie to the opposite 4kV bus given failure of the dedicated diesel.	Quad Cities Application for License Renewal [F-8]	I – See Item 91. Procedure step does not currently exist and automatic cross-tie is not pursued in favor of manual actuation. Auto-closure is more expensive and, in this case, may increase the potential to auto-close into a fault. The PRA team's assessment is that the preferred course of action is for the operators to manually diagnose and control the evolution based on actual plant conditions.	No (See SAMA 91)
34	Create a backup source for diesel cooling. (Not from existing system)	This SAMA would provide a redundant and diverse source of cooling for the diesel generators, which would contribute to enhanced diesel reliability.	Quad Cities Application for License Renewal [F-8]	N/A – Oyster Creek EDGs are air cooled.	No
35	Provide procedures for (a) bypassing major DC buses; (b) locally starting equipment	This SAMA would allow for powering specific loads given a DC bus failure and/or the ability to start equipment locally that normally requires DC power for a control room start.	Quad Cities Application for License Renewal [F-8]	D – Oyster Creek has procedures for Operating breakers manually (See ABN-53).	No
36	Delete High DW Pressure Signal from SDC isolation	This SAMA would allow the initiation of SDC when the drywell is at elevated pressures.	Quad Cities Application for License Renewal [F-8]	I – See Item 89 for disposition.	No (See SAMA 89)

Table F-15. Phase I SAMA Evaluation

NO.	SAMA TITLE	SAMA DESCRIPTION	SOURCE	PHASE I DISPOSITION	RETAINED FOR PHASE II ANALYSIS?
81	Improve training on Alternate Instruments	NMP1 alternate instruments in East and West instrument rooms are significant assets in PRA, augmented training for IC operation could be valuable.	Nine Mile Point 1 Application for License Renewal [F-11]	I – Included as SAMA 99.	No (See SAMA 99)
82	Reduce fire risk	Reduction in sources, relatively simple cable re-routing, and/or additional use of thermography could reduce CDF.	Nine Mile Point 1 Application for License Renewal [F-11]	I – See Item 125 for disposition.	No (See SAMA 125)
83	Reduce Offsite power recovery dependency on Div 11 DC	Add DC source or justify manual manipulation for offsite AC power recovery	Nine Mile Point 1 Application for License Renewal [F-11]	N/A – Plant specific item for NMP1.	No
84	Manually operate containment vent valves	Provide capability to vent primary containment without support systems with procedure/training	Nine Mile Point 1 Application for License Renewal [F-11]	R – Oyster Creek has dedicated air accumulators for Containment hard pipe vent valves as well as redundant (AC and DC) power supply for the related solenoid valves. While this is a highly reliable configuration which leads to a low risk impact, the use of handwheels could potentially be cost-beneficial and is retained for further analysis.	Yes
85	Provide an alternate DC charger	Portable unit for temp alignment to divisional batteries with procedure/training	Nine Mile Point 1 Application for License Renewal [F-11]	I – See Item 109 for disposition.	No (See SAMA 109)
86	Improve AC power load management	Provide training on potential impact of PB16A &16B crosstie (17A &17B)	Nine Mile Point 1 Application for License Renewal [F-11]	I – Plant specific issue for NMP1, transformer loading limitation. Note that an Oyster Creek specific AC cross-tie is included as SAMA 91.	No (See SAMA 91)
87	Improve procedures/training for loss of air	Improve reliability of operator action to ensure that feedwater is available as RPV makeup source on loss of air	Nine Mile Point 1 Application for License Renewal [F-11]	D – Oyster Creek has a procedure for local manual control of feedwater. The CST to hotwell valves fail open (fail safe for FW operation) given a loss of air.(1)	No

F.6.7 SAMA 67: SAFETY RELATED CONDENSATE STORAGE TANK

SAMA 67 represents a potential modification to enable the CST to survive a larger portion of the seismic spectrum. The modification to strengthen the seismic capability of the CST is judged only to impact the seismic risk contribution. Therefore, the fire and internal events risk contributions are assumed to remain unchanged.

The current Oyster Creek PRA model does not include seismic initiating events. However, the IPEEE evaluation [F-22] built a seismic model that can be used to estimate the potential benefit of this proposed modification. Seismic CDF is 3.63E-6/yr and no containment event tree was developed for use with seismic events.

In the IPEEE, the seismic induced failure of the condensate storage tank was modeled using top event SX. The following table shows the failure rate under various conditions modeled in the seismic PRA.

Model Identifier	Condition	Failure Rate (EPRI NP-6395-D Hazard Curve)	Failure Rate of Containment Spray Components (Safety Related) For Comparison
SX1	CST Failure given earthquake between 0.007g and 0.26g	4.91E-3	4.74E-5
SX2	CST Failure given earthquake between 0.26g and 0.46g	0.522	4.43E-2
SX3	CST Failure given earthquake between 0.46g and 0.62g	0.833	0.296
SX4	CST Failure given earthquake between 0.62g and 0.82g	0.935	0.648

The Fussell-Vesely (FV) importance measure from the IPEEE[(1)] for the SX Top event is 0.31 which means that the seismic induced failure of the CSTs occurs in approximately 31% of seismic core damage sequences. Given the fairly high seismic failure rate for CSTs, it is judged reasonable to assume that designing the CSTs to standards equal to safety related components would reduce CST failure sequences by a factor of 5. Such a change would reduce seismic CDF from 3.63E-6/yr to 2.73E-6/yr (3.63E-6*((1-0.31)+(0.31/5))). The results from this case indicate a 24.8 percent reduction in seismic CDF (CDF_{new}= 2.73E-6 per year). This is conservative for the SAMA evaluation relative to the alternative seismic model assessment.

(1) A 0.31 FV within the 3.63E-6/yr seismic CDF described in the IPEEE. During the IPEEE RAI process, an alternative model was discussed which yielded a seismic CDF of 4.7E-6/yr. This alternative model is discussed in the June 29, 2000 RAI response to the NRC. On Page 30 of this RAI response, Oyster Creek reported that the SX top event has a 5.48E-2 FV when using the alternative seismic PRA model with a CDF of 4.7E-6/yr. Thus, for the SAMA evaluation, it is more conservative to assess the benefit using the seismic model with the highest frequency for affected sequences, that is, the IPEEE seismic model (i.e., IPEEE: 3.63E-6/yr*0.31=1.13E-6/yr; versus the alternative seismic model 4.7E-6/yr*0.0548=2.58E-7/yr).

Based on review of the top 20 dominant seismic sequences (representing approximately 50% of the seismic CDF), as documented in the Oyster Creek IPEEE submittal report, the breakdown of the base seismic CDF as a function of core damage accident type is as follows:

- Class IA(Late): 15%
- Class IB(Early): 80%
- Class IIIB: 5%

This distribution has removed the seismic induced catastrophic failure of the Turbine Building and Reactor Building. This is considered appropriate for the delta risk assessment of the block wall.

The Oyster Creek seismic IPEEE analysis does not include a Level 2 analysis; however, a reasonable approximation of release frequency distribution can be made, as follows:

- Use the above seismic CDF accident class distributions for the entire seismic CDF.
- Apply the release category probabilities as a function of accident class obtained from the Oyster Creek internal events PRA, except for one modification. Seismic IB scenarios involve switchyard structural failures that are assumed not recoverable within the PRA mission time. As the internal events Class IBE (Station Blackout) credits AC power recovery (which is inappropriate for Class IB seismic scenarios), the internal events Class ID release distribution is applied to the seismic Class IBE scenarios. The internal events Class ID scenarios reasonably simulate seismic Class IBE scenarios in that recovery of injection in the internal events Level 2 for Class ID scenarios is negligible.
- Adjust release category timings to reflect potential inability to evacuate by making the category times shorter by one category for each release state (i.e., H/I is added to H/E, H/L becomes new H/I, etc.). This accounts for the negative impacts on offsite mitigation efforts (e.g., evacuation) caused by seismic effects on the surrounding infrastructures (e.g., roads, bridges).

Using this approach, the release frequency as a function of accident class for the Oyster Creek base seismic risk profile is as follows:

Oyster Creek Seismic Base Release Profile Frequencies (/yr)

Accident Class	CDF	Intact	L-LL/E, L-LL/I	L-LL/L	M/E	M/I	M/L	H/E	H/I	H/L	BOC
IA (Late)	5.45E-7	1.07E-08	3.57E-07	6.91E-08	0.00E+00	1.64E-08	0.00E+00	0.00E+00	9.10E-08	0.00E+00	0.00E+00
ID	2.90E-6	1.77E-06	9.95E-08	1.24E-08	9.73E-07	0.00E+00	0.00E+00	4.95E-08	0.00E+00	0.00E+00	0.00E+00
IIIB	1.82E-7	1.26E-07	8.75E-10	6.59E-11	6.65E-09	4.42E-09	1.36E-10	9.67E-09	1.68E-08	1.75E-08	0.00E+00
Totals:	3.63E-6	1.90E-06	4.57E-07	8.16E-08	9.79E-07	2.09E-08	1.36E-10	5.92E-08	1.08E-07	1.75E-08	0.00E+00

Seismic CDF and Release Risk Profile for SAMA #67

Based on the discussion above, this SAMA would reduce the seismic IPEEE calculated CDF from 3.63E-6/yr to 2.73E-6/yr (e.g., approximately 5.4E-7/yr). This reduction is apportioned to each of the three seismic accident classes using the same ratios as the base seismic results (i.e., 15%, 80%, and 5%). The resulting release frequency as a function of accident class for this SAMA item is as follows:

Release Profile Frequencies (/yr) for SAMA #67

Accident Class	CDF	Intact	L-LL/E, L-LL/I	L-LL/L	M/E	M/I	M/L	H/E	H/I	H/L	BOC
IA (Late)	4.10E-07	8.05E-09	2.68E-07	5.20E-08	0.00E+00	1.24E-08	0.00E+00	0.00E+00	6.83E-08	0.00E+00	0.00E+00
ID	2.18E-06	1.33E-06	7.49E-08	9.31E-09	7.33E-07	0.00E+00	0.00E+00	3.73E-08	0.00E+00	0.00E+00	0.00E+00
IIIB	1.37E-07	9.44E-08	6.56E-10	4.94E-11	4.98E-09	3.31E-09	1.02E-10	7.25E-09	1.26E-08	1.31E-08	0.00E+00
Totals	2.73E-06	1.43E-06	3.44E-07	6.13E-08	7.38E-07	1.57E-08	1.02E-10	4.45E-08	8.10E-08	1.31E-08	0.00E+00

Cost-Benefit Calculation for SAMA #67

Using the above seismic risk profiles, and the dose and economic information presented in Section F.3, the economic cost risk for the base seismic risk profile and the SAMA #67 (Sensitivity Case) risk profiles are summarized below:

Oyster Creek Seismic Base OECR Results

Risk Metric	CDF	Intact	L-LL/E, L-LL/I	L-LL/L	M/E	M/I	M/L	H/E	H/I	H/L	BOC
Freq. (/yr)	3.63E-6	1.90E-06	4.57E-07	8.16E-08	9.79E-07	2.09E-08	1.36E-10	5.92E-08	1.08E-07	1.75E-08	0.00E+00
Dose-Risk (person rem/yr)	8.71E+00	4.76E-02	1.84E+00	1.21E-02	5.67E+00	8.76E-02	4.80E-04	4.69E-01	4.52E-01	1.31E-01	0.00E+00
OECR ($/yr)	2.85E+04	1.89E+01	5.40E+03	9.87E+00	1.87E+04	2.65E+02	1.31E+00	2.23E+03	1.17E+03	6.58E+02	0.00E+00

SAMA #67 OECR Results

Risk Metric	CDF	Intact	L-LL/E, L-LL/I	L-LL/L	M/E	M/I	M/L	H/E	H/I	H/L	BOC
Freq. (/yr)	2.73E-06	1.43E-06	3.44E-07	6.13E-08	7.38E-07	1.57E-08	1.02E-10	4.45E-08	8.10E-08	1.31E-08	0.00E+00
Dose-Risk (person rem/yr)	6.56E+00	3.58E-02	1.38E+00	9.07E-03	4.27E+00	6.59E-02	3.60E-04	3.53E-01	3.39E-01	9.83E-02	0.00E+00
OECR ($/yr)	2.14E+04	1.42E+01	4.06E+03	7.42E+00	1.41E+04	1.99E+02	9.82E-01	1.68E+03	8.83E+02	4.93E+02	0.00E+00

The cost of implementation for this SAMA is estimated to be $1,000,000.

This information was used as input to the cost benefit calculation. The results of this calculation are provided in the following table:

SAMA #67 Net Value

Base Case: Cost-Risk[1] for Oyster Creek (site)[2]	Cost-Risk for Oyster Creek With SAMA Changes	Averted Cost-Risk	Cost of Implementation	Net Value
$559,000	$420,000	$139,000	$1,0000,000	-$861,000

(1) Present Value Cost-Risk. The derivation of the present value cost-risk includes the OECR plus the other contributors to cost-risk described in Section F.3.

(2) This includes only the seismic contribution to risk as that is the only portion of risk considered impacted by this SAMA.

Given that the cost of implementation is greater than the averted cost-risk for this SAMA, this enhancement is not cost beneficial based on the SAMA methodology.

With respect to the 95% CDF sensitivity, this SAMA would result in an averted cost of $347,500, for this case. This would continue to result in the SAMA being considered not cost-beneficial.

F.6.16 SAMA 100: CONNECT SBO TRANSFORMER TO BOTH AC DIVISIONS.

Presently, the combustion turbine supplies only the "B" bus directly via the SBO transformer. Modification of the circuit to allow the combustion turbines to also supply the "A" bus directly would be beneficial. This would provide a benefit similar to SAMA 91 except that equipment such as feedwater pumps that are powered from Bus A would also be potentially available.

This modeling change to address this option was accomplished by making the same changes as noted in SAMA 91 as well as adding new basic events to represent the condensate/feedwater system as well as additional decay heat removal paths. Specifically, under gate ECCS-HDWR-SBO 2 basic events were added: SAMA139-FW-INJ (1E-2) to represent additional feedwater system availability and SAMA139-DHR-COND (0.1) to represent realignment of additional heat removal paths such as the main condenser and containment venting. This is judged optimistic toward supporting this SAMA because the base model takes little credit for these success paths even though Bus B is currently available from the CTs.

The results from this case indicate a 3.7 percent reduction in CDF (CDF_{new}=1.01E-5 per year). A further breakdown of this information is provided below according to release category.

SAMA 100 PRA and MACCS Results By Release Category

Calculation Description	Total	Release Category									
		Intact	L-LL/E, L-LL/I	L-LL/L	M/E	M/I	M/L	H/E	H/I	H/L	BOC
Baseline Freq. (per yr.)	1.05E-05	2.71E-06	3.38E-06	1.96E-07	9.99E-07	1.66E-06	1.67E-09	5.48E-07	7.86E-07	2.10E-07	3.23E-08
SAMA Freq. (per yr.)	1.01E-05	2.64E-06	3.16E-06	1.95E-07	9.63E-07	1.64E-06	1.67E-09	5.63E-07	7.54E-07	2.10E-07	3.23E-08
SAMA Dose-Risk (Person Rem/yr.)	3.46E+01	6.60E-02	1.27E+01	2.89E-02	5.58E+00	6.87E+00	5.90E-03	4.21E+00	3.16E+00	1.58E+00	4.01E-01
SAMA OECR ($/yr.)	1.14E+05	2.62E+01	3.73E+04	2.36E+01	1.84E+04	2.08E+04	1.61E+01	2.00E+04	8.22E+03	7.91E+03	1.17E+03

System managers have estimated the cost of the modification to be $500,000.

This information was used as input to the cost benefit calculation. The results of this calculation are provided in the following table:

SAMA Number 100 Net Value

Base Case: Cost-Risk[1] for Oyster Creek (site)	Cost-Risk for Oyster Creek With SAMA Changes	Averted Cost-Risk	Cost of Implementation	Net Value
$4,462,000	$4,316,000	$146,000	$500,000	-$354,000

[1] Present Value Cost-Risk. The derivation of the present value cost-risk includes the OECR plus the other contributors to cost-risk described in Section F.3.

Given that the cost of implementation is greater than the averted cost-risk for this SAMA, this enhancement is not cost beneficial based on the SAMA methodology. However, note that a significant portion of this benefit can also be achieved by implementation of SAMA 91, the 4160 VAC cross-tie option.

Table F-19. Summary of the Detailed Phase II SAMA Analyses

Phase II SAMA ID	Averted Cost-Risk	Cost of Implementation	Net Value	Cost Beneficial?(5)
SAMA 7	$174,000	$500,000	-$326,000	no
SAMA 10	$788,000	$1,000,000	-$212,000	no
SAMA 18	$8,000	$265,000	-$257,000	no
SAMA 20	$4,000	$400,000	-$396,000	no
SAMA 23	$42,000	$150,000	-$108,000	no
SAMA 25	$4,000	$50,000	-$46,000	no
SAMA 67	$65,000	$1,000,000	-$935,000	no
SAMA 84	$80,000	$150,000	-$70,000	no
SAMA 88	$0	$50,000	-$50,000	no
SAMA 89	(1)	$50,000	(1)	no
SAMA 91	$118,000	$90,000	+$28,000	yes
SAMA 92	$36,000	$100,000	-$64,000	no
SAMA 94	$0	$50,000	-$50,000	no
SAMA 95	(2)	$50,000	(2)	no
SAMA 99	$674,000	$150,000	+$524,000	yes
SAMA 100	$146,000	$500,000	-$354,000	no
SAMA 101	$0	$50,000	-$50,000	no
SAMA 102	$0	$100,000	-$100,000	no
SAMA 104	$44,000	$250,000	-$206,000	no
SAMA 106	$34,000	$50,000	-$16,000	no
SAMA 107	$0	$150,000	-$150,000	no
SAMA 108	(1)	~$500,000 (est.)	(1)	no
SAMA 109	$674,000	$75,000	+$599,000	yes
SAMA 110	(1)	~$75,000	(1)	no
SAMA 111	(1)	$500,000	(1)	no
SAMA 112	$8,000	$1,000,000	-$992,000	no
SAMA 124	$84,000	$150,000	-$66,000	no
SAMA 125B	$333,000	$100,000	+$233,000	yes
SAMA 125C	$397,000	$750,000	-$353,000	no
SAMA 127	(4)	(4)	(4)	yes
SAMA 128	$0	$200,000	-$200,000	no
SAMA 129	$56,000	$100,000	-$44,000	no
SAMA 130	$747,000	$600,000	+$147,000	yes
SAMA 132	$46,000	$50,000	-$4,000	no
SAMA 133	$72,000	$250,000	-$178,000	no
SAMA 134	$438,000	$150,000	+$288,000	yes
SAMA 136	$0	$100,000	-$100,000	no
SAMA 138	$446,000	$780,000	-$334,000	no

F.7.2 95TH PERCENTILE PRA RESULTS

The results of the SAMA analysis can be impacted by implementing conservative values from the PRA uncertainty distribution. If the best estimate failure probability values are consistently lower than the "actual" failure probabilities, the PRA model would underestimate plant risk and yield lower than "actual" averted cost-risk values for potential SAMAs. Re-assessing the cost benefit calculations using the high end of the failure probability distribution is a means of identifying the impact of having consistently underestimated failure probabilities for plant equipment and operator actions included in the PRA model.

The 95th percentile core damage frequency (CDF) results are estimated for Oyster Creek for use in the reassessment. It is assumed that the factor by which the 95th percentile CDF results exceed the point estimate CDF is similar for many industry PRA models. While the degree of incorporation of plant specific data varies from plant to plant, the use of a similar generic database and the methods used to incorporate plant specific data are becoming more standardized. As a result, the characteristics of data uncertainties should be trending toward conformity.

The following is a summary of the point estimate CDF and 95th percentile CDFs for three SAMA submittals:

Plant	Point Estimate CDF	95th Percentile CDF	Factor by Which the 95th Percentile Results are Greater than the Point Estimates
V.C. Summer	5.59×10^{-5}/yr	1.32×10^{-4}/yr	2.36
Robinson	4.32×10^{-5}/yr	1.06×10^{-4}/yr	2.45
Brunswick	4.19×10^{-5}/yr	9.83×10^{-5}/yr	2.35

For the plants identified above, the 95th percentile CDF is between 2.35 and 2.45 times greater than the point estimate CDF. A factor of 2.5 is greater than the other industry examples and is judged acceptable for identifying the impact of data uncertainty on the Oyster Creek SAMAs.

PHASE I IMPACT

For Phase I screening, use of the 95th percentile CDF results will increase the modified maximum averted cost-risk and may prevent the screening of some of the higher cost modifications. However, the impact on the overall SAMA results due to the retention of the higher cost SAMAs for Phase II analysis is small. This is due to the fact that the benefit gleaned from the implementation of those SAMAs must be extremely large in order to be cost beneficial.

The impact of uncertainty in the PRA results on the Phase I SAMA analysis is examined as described above and reported in Table F.7-1.

As discussed above, the 95th percentile CDF results are assessed to be a factor of 2.5 greater than the point estimate CDF. For Oyster Creek, this corresponds to a CDF at the 95th percentile of 2.63E-5/yr. The dose-risk and offsite economic cost-risk are also increased by a factor of 2.5 to simulate the increase in the CDF resulting from the use of the 95th percentile CDF.

The Phase I SAMA list of Table F-15 has been re-examined using the revised modified maximum averted cost-risk to assess the impact of this set of assumptions. Table F.7-1 summarizes the results of this review[(1)]. No items evaluated in Phase I for transfer to Phase II were changed based on the sensitivity screening documented in Table F.7-1.

PHASE II IMPACT

The 95th percentile results have been represented by increasing the base dose-risk and offsite economic cost-risk in proportion to the Level 1 results. The factor of 2.5 is also assumed to propagate through the results for the model runs performed for the Phase II detailed calculations. This means that the averted cost-risks for each case will be increased by the same factor.

Table F.7-3 provides a summary of the impact of using the 95th percentile CDF results in the detailed cost benefit calculations that have been performed as part of Phase II.

When the 95th percentile CDF results are used, eight of the Phase II SAMAs that were previously classified as "not cost beneficial", using a realistic assessment of risk, are determined to be cost beneficial. Table F.7-4 summarizes these eight SAMAs. However, the use of the 95th percentile PRA results is not considered to provide the most realistic assessment of the cost effectiveness of a SAMA. Nevertheless, this information is included for decision-maker use in evaluating the impact of uncertainties.

The $750,000 cable rerouting based option for fire mitigation would be cost-beneficial under the 95th percentile sensitivity as it is structured. This option is discussed as case 125 C in Section F.6.28. With an averted cost of $397,000 and an implementation cost of $750,000, the option would become cost-beneficial if the averted cost were multiplied by 2.5 as per the 95th percentile case. This option would not be considered cost beneficial under the conditions that are applied to the 3% RDR sensitivity. This option is not highlighted further in this section because, as noted in Section F.6.28, the cost of rerouting cables has been conservatively estimated and it is not considered likely that this improvement would be ultimately cost-beneficial using a more detailed cost estimate.

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(1) The investigation into the two types of sensitivities is documented in Table F.7-1. As a short cut to understanding and evaluating the sensitivities, it is noted that:

(1) The use of an RDR of 3% results in an increase in averted cost of a factor of 1.4
(2) The use of the 95% upper bound results in an increase in averted cost of approximately 2.5

Therefore, a screening can be performed using the factor of 2.5 increase to bound the maximum averted cost for each of the SAMAs. This value can then be compared with the individual SAMA costs to provide a conservative method of screening for <u>both</u> sensitivities.

Table F.7-2. Summary of SAMA Discount Sensitivity

SAMA ID	Cost of Implementation ($)	7 % RDR Averted Cost- Risk ($)	7 % RDR Net Value ($)	3 % RDR Averted Cost- Risk ($)	3 % RDR Net Value ($)	Change in Cost Effectiveness to make the SAMA Cost Beneficial?
7	500,000	174,000	-326,000	240,000	-260,000	No
10	1,000,000	788,000	-212,000	1,088,000	88,000	No(2)
18	265,000	8,000	-257,000	10,000	-255,000	No
20	400,000	4,000	-396,000	6,000	-394,000	No
23	150,000	42,000	-108,000	58,000	-92,000	No
25	50,000	4,000	-46,000	6,000	-44,000	No
67	1,000,000	65,000	-935,000	88,000	-912,000	No
84	150,000	80,000	-70,000	110,000	-40,000	No
88	50,000	0	-50,000	0	-50,000	No
89	50,000	0	-50,000	0	-50,000	No
91	90,000	118,000	+28,000	162,000	+72,000	No(1)
92	100,000	36,000	-64,000	50,000	-50,000	No
94	50,000	0	-50,000	0	-50,000	No
95	50,000	0	-50,000	0	-50,000	No
99	150,000	674,000	+524,000	928,000	+778,000	No(1)
100	500,000	146,000	-354,000	204,000	-296,000	No
101	50,000	0	-50,000	0	-50,000	No
102	100,000	0	-100,000	0	-100,000	No
104	250,000	44,000	-206,000	60,000	-190,000	No
106	50,000	34,000	-16,000	46,000	-4,000	No
107	150,000	0	-150,000	0	-150,000	No
108	500,000	0	-500,000	0	-500,000	No
109	75,000	674,000	+599,000	928,000	+853,000	No(1)
110	75,000	0	-75,000	0	-75,000	No
111	500,000	0	-500,000	0	-500,000	No
112	1,000,000	8,000	-992,000	10,000	-990,000	No
124	150,000	84,000	-66,000	115,000	-35,000	No
125B	100,000	333,000	233,000	458,000	358,000	No(1)
125C	750,000	397,000	-353,000	540,000	-210,000	No
127	50,000	(3)	(3)	(3)	(3)	No(3)
128	200,000	0	-200,000	0	-200,000	No
129	100,000	56,000	-44,000	76,000	-24,000	No
130	600,000	747,000	+147,000	1,032,000	+432,000	No
132	50,000	46,000	-4,000	64,000	+14,000	Yes
133	250,000	72,000	-178,000	100,000	-150,000	No
134	150,000	438,000	+288,000	606,000	+456,000	No(1)
136	100,000	0	-100,000	0	-100,000	No
138	780,000	446,000	-334,000	616,000	-164,000	No

Table F.7-3. Summary of 95th Percentile Sensitivity Analysis

SAMA ID	Cost of Implementation ($)	Base Averted Cost- Risk ($)	Base Net Value ($)	95% Averted Cost- Risk($)	95% Net Value($)	Change in Cost Effectiveness to make the SAMA Cost Beneficial?
7	500,000	174,000	-326,000	435,000	-65,000	No
10	1,000,000	788,000	-212,000	1,970,000	970,000	Yes
18	265,000	8,000	-257,000	20,000	-245,000	No
20	400,000	4,000	-396,000	10,000	-390,000	No
23	150,000	42,000	-108,000	105,000	-45,000	No
25	50,000	4,000	-46,000	10,000	-40,000	No
67	1,000,000	65,000	-935,000	162,500	-837,500	No
84	150,000	80,000	-70,000	200,000	50,000	Yes
88	50,000	0	-50,000	0	-50,000	No
89	50,000	0	-50,000	0	-50,000	No
91	90,000	118,000	28,000	295,000	205,000	No(1)
92	100,000	36,000	-64,000	90,000	-10,000	No
94	50,000	0	-50,000	0	-50,000	No
95	50,000	0	-50,000	0	-50,000	No
99	150,000	674,000	524,000	1,685,000	1,535,000	No(1)
100	500,000	146,000	-354,000	365,000	-135,000	No
101	50,000	0	-50,000	0	-50,000	No
102	100,000	0	-100,000	0	-100,000	No
104	250,000	44,000	-206,000	110,000	-140,000	No
106	50,000	34,000	-16,000	85,000	35,000	Yes
107	150,000	0	-150,000	0	-150,000	No
108	500,000	0	-500,000	0	-500,000	No
109	75,000	674,000	599,000	1,685,000	1,610,000	No(1)
110	75,000	0	-75,000	0	-75,000	No
111	500,000	0	-500,000	0	-500,000	No
112	1,000,000	8,000	-992,000	20,000	-980,000	No
124	150,000	84,000	-66,000	210,000	60,000	Yes
125B	100,000	333,000	233,000	832,500	732,500	No(1)
125C	750,000	397,000	-353,000	992,500	242,500	Yes
127	50,000	(2)	(2)	(2)	(2)	No(2)
128	200,000	0	-200,000	50,000	-200,000	No
129	100,000	56,000	-44,000	140,000	40,000	Yes
130	600,000	747,000	147,000	1,867,500	1,267,500	No(1)
132	50,000	46,000	-4,000	115,000	65,000	Yes
133	250,000	72,000	-178,000	180,000	-70,000	No
134	150,000	438,000	288,000	1,095,000	945,000	No(1)
136	100,000	0	-100,000	0	-100,000	No
138	780,000	446,000	-334,000	1,115,000	335,000	Yes

Table F.7-4
Summary of "New" Cost Beneficial SAMAs if CDF Increased to 95th Percentile

SAMA No.	Description	Discussion	Competing Risks Accounted for
124	Block wall 53 reinforcement	The 95th percentile sensitivity is considered an extreme case. Also, the benefit is based on the IPEEE seismic analysis which was not performed with the intent of supporting detailed cost-benefit assessments. Also, the seismic analysis has not been updated since it was completed in 1996.	No significant competing risks noted.
125C	Cable re-routing in 480V AC "A" switchgear room	Using the 95th percentile sensitivity assessment and the "low" cost of implementation results in a cost beneficial case.	Competing risks could be significant but are <u>not</u> accounted for.
129	Internal Flooding Procedure Enhancements	The 95th percentile sensitivity is considered an extreme case. Also, the benefit is based on an assumed factor of two improvement in operator capability that is difficult to achieve and represents an upper bound judgment of the potential for benefit.	It is noted that there is competing risk in that operator time and attention focused on internal flooding will divert operator training from other, higher, safety significant activities. This competing risk is not accounted for in the calculations.
132	When both CTs are in operation, alignment for Oyster Creek LOOP response takes additional time due to need for CTs to coast down prior to switching. This SAMA would eliminate procedural guidance to shutdown CTs, if initially running.	Under the extreme conditions of the 95th percentile sensitivity assessment, this SAMA becomes cost-beneficial.	No significant competing risks noted.
138	The main and startup transformers are located approximately 15' apart. There is a concern that a failure of one could impact the other.	Under the extreme conditions of the 95th percentile sensitivity assessment, this SAMA becomes cost-beneficial.	No significant competing risks noted.

Priority	SAMA No.	Description	Best Est. Net Value (20 yr. Life)
1	109	Portable DC Battery Charger to Preserve IC and EMRV Operability Along With Adequate Instrumentation	$599,000
2	134	Upgrade Fire Pump House Structural Integrity	$288,000
3	125B	480V AC switchgear circuit breaker addition(1)	$233,000
4	127	Operator Training	Judgment

(1) It is noted that SAMA 125 related to reduction in the fire induced CDF in the 480V AC switchgear room is found cost beneficial with or without SAMA 109 implementation. If SAMA 109 is not implemented, the more capital intensive change 125C should be considered.

An examination of SAMA combinations found no significant positive synergies among the individual SAMAs that alter the overall conclusions of the individual SAMA evaluations, i.e., no increase in net value when multiple SAMAs are implemented together.

F.8.3 SENSITIVITY ANALYSIS RESULTS

The list of SAMAs have also been assessed using different assumptions for two key inputs to examine the impact of uncertainties:

- The estimate of core damage frequency
- The real discount rate (RDR)

The results of these sensitivity cases provide yet another perspective on the results of the SAMA evaluation reflecting the uncertainty in these two input variables.

F.8.3.1 RDR Change: A Sensitivity Evaluation

The change in RDR from 7% to 3% causes one additional SAMA to be considered cost beneficial. Table F.8-2 summarizes this SAMA.

It is noted that the net value for the "new" candidate SAMA is not significant given the nature of the sensitivities and the conservatism involved in the overall assessment of these SAMA. Therefore, no significant insight is judged derived from these sensitivity analyses that affect the decisions.

These insights are not viewed as significant compared to other insights from this study but are included for decision-maker use in evaluating uncertainty impacts on the cost-benefit calculation.

Table F.8-2. Summary of Additional Cost Beneficial SAMA if RDR Changed to 3%

		Net Value	
SAMA No.	SAMA DESCRIPTION	Best Est. (7% RDR)	3% RDR
132	When both CTs are in operation, alignment for Oyster Creek LOOP response takes additional time due to need for CTs to coast down prior to switching. This SAMA would eliminate procedural guidance to shutdown CTs, if initially running,	-$4,000	$14,000

F.8.3.2 Risk Profile Changes: A Sensitivity Evaluation

If the CDF used in the risk analysis increased to the 95th percentile, then the cost-risk for the individual SAMAs will increase because of the additional perceived risk. Using this extreme assumption results in the addition of eight (8) SAMAs to the list of SAMAs that could be considered by decision-makers. Table F.8-3 summarizes this list of eight (8) SAMAs along with the net value calculated for the best estimate evaluation and the 95th percentile sensitivity evaluation.

However, the use of the 95th percentile PRA results is not considered to provide the most realistic assessment of the cost effectiveness of a SAMA. Nevertheless, this information is included for decision-maker use in evaluating the impact of uncertainties.

Table F.8-3. Summary of Additional Cost Beneficial SAMA If CDF Increased to 95th Percentile

SAMA No.	Description	Net Value: Best Est.	Net Value: 95th Percentile CDF
10	This SAMA would reduce the risk of catastrophic failure of the containment. The current Torus Hard Pipe Vent includes a rupture disk beyond an isolation valve; however, an alternate path to the Torus Hard Pipe Vent could be made in the wetwell using a rupture disk that would fail at about 60 psid. Alternatively, the containment vent valves could be changed so that they "fail open" on loss of support. Given this change, the vent path would be open on loss of support with the exception of the rupture disk. To prevent premature opening of the vent path during scenarios with loss of vent valve support, the strength of the rupture disk could be increased so that it is closer to the EOP vent pressure.	-$212,000	$970,000(1)
84	Provide capability to vent primary containment without support systems with procedure/training	-$70,000	$50,000
106	Revise ABN-19 to include guidance to implement a <90°F/hr cooldown as soon as possible following a loss of RBCCW to supplement protection of recirc seals by reducing RPV pressure.	-$16,000	$35,000
124	Block wall 53 reinforcement	-$66,000	$60,000
125C	Cable re-routing in 480V AC "A" switchgear room	-$353,000	$242,500(1)
129	Internal Flooding Procedure Enhancements	-$44,000	$40,000(1)
132	When both CTs are in operation, alignment for Oyster Creek LOOP response takes additional time due to procedure for CTs to coast down prior to switching. This SAMA would change the procedure such that they can be switched to the SBO transformer under load, eliminating the need for the CTs to coast down, if running.	-$4,000	$65,000
138	The main and startup transformers are located approximately 15' apart. There is a concern that a failure of one could impact the other.	-$334,000	$335,000

(1) Competing risks could be significant, but are not accounted for.